RESPONSE ACTION CONTRACT
FOR REMEDIAL RESPONSE, ENFORCEMENT OVERSIGHT,
CRITICAL REMOVAL ACTIVITIES AT SITES OF RELEASE OR
THREATENED RELEASE OF HAZARDOUS SUBSTANCES
IN EPA REGION 2

3/14/2008

FINAL QUALITY ASSURANCE PROJECT PLAN

OLD ROOSEVELT FIELD CONTAMINATED GROUNDWATER AREA SITE REMEDIAL DESIGN GARDEN CITY, NEW YORK

Work Assignment No. 178-RDRD-02PE

U.S. EPA CONTRACT NO. 68-W-98-210
Document Control No.: 3223-178-PP-QAPP-07158
March 14, 2008

Prepared for:
U.S. Environmental Protection Agency
290 Broadway
New York, New York 10007-1866

Prepared by:
CDM Federal Programs Corporation
125 Maiden Lane, 5th Floor
New York, New York 10038

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Title and Approval Page

FINAL QUALITY ASSURANCE PROJECT PLAN (QAPP)
for
Old Roosevelt Field Contaminated Groundwater Area Site
Remedial Design
Garden City, New York

US Environmental Protection Agency (EPA) Region 2

Prepared by: CDM Federal Programs Corporation (CDM)
125 Maiden Lane, 5th Floor
New York, NY 10038
(212) 785-9123

Date: March 14, 2008

CDM Project Manager:

Signature_______________
Susan Schofield, P.G.

CDM QA Manager:

Signature_______________
Doug Updike

EPA Project Manager:

Signature_______________
Caroline Kwan

CDM RAC II Program Manager:

Signature_______________
Jeanne Litwin, REM

EPA Region 2 Hazardous Waste Support Section

Signature_______________
Linda Mauel

Document Control Number: 3223-178-PP-QAPP-07158

QAPP Worksheet #2
QAPP Identifying Information

Site Name/Project:	Old Roosevelt Field Contaminated Groundwater Area Site Remedial Design
Site Location:	Garden City, New York
Operable Unit:	Not Applicable (NA)
Contractor Name:	CDM
Contractor Number:	68-W-98-210
Contract Title:	Response Action Contract Region 2
Work Assignment Number:	178-RDRD-02PE
Regulatory Program:	CERCLA
Approval Entity:	EPA Region 2
Is QAPP Generic or Project Specific:	Project Specific
Dates of scoping sessions:	January 14, 2008

Dates and Titles of QAPP Documents Written for Previous Site Work, if Applicable:
Final Quality Assurance Project Plan (QAPP), Old Roosevelt Field Contaminated Groundwater Area Site: June 20, 2005; Final QAPP Addendum, Old Roosevelt Field Contaminated Groundwater Area Site: October 12, 2005.

Organizational Partners (stakeholders) and Connection with Lead Organization:
New York State Department of Environmental Conservation (NYSDEC)

Data Users:
CDM, EPA Region 2, New York State Department of Environmental Conservation (NYSDEC)

Required QAPP elements and required information that are not applicable to the project, and an explanation for their exclusions:
N/A

QAPP Worksheet #2
QAPP Identifying Information
(continued)

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Old Roosevelt Field Contaminated Groundwater Area Site Summary
Garden City, New York

The information below briefly summarizes the site description, the site background and the findings of the RI/FS. The primary ROD requirements for the selected remedy are presented. Additional information can be found on Worksheet #10.

Site Description

The site is an area of groundwater contamination within the Village of Garden City in central Nassau County, New York. The site is located on the eastern side of Clinton Road, south of the intersection with Old Country Road, and includes the area of the former Roosevelt Field airfield. The former Roosevelt Field airfield area is currently developed as a large retail shopping mall with a number of restaurants, and a movie theater. Several office buildings (including Garden City Plaza) are on the western perimeter of the mall and share parking space with the mall. A thin strip of open space along the eastern side of Clinton Road (known as Hazelhurst Park) serves as designated parkland and a buffer between the residential community on the west side of Clinton Road and the mall complex. Two recharge basins are directly south of the mall/office area. One basin is known as Pembrook Basin and is on property owned by the mall. The second basin is Nassau County Recharge Basin number 124. Two municipal supply well fields are located south (downgradient) of the former airfield: The Village of Garden City public supply wells 10 and 11, on the eastern side of Clinton Road. The Village of Hempstead Wellfield is located approximately one mile south of the Garden City supply wells.

Site History and Background

The site was used for aviation activities from 1911 to 1951. The original airfield was known as the Hempstead Plains Aerodrome and encompassed 900 to 1,000 acres east of Clinton Road and south of Old Country Road. During its first three years, activities at the airfield included civilian flight training, equipment testing, and aerial stunt shows.

The United States (U. S.) military began using the Hempstead Plains field prior to World War I. In 1918, the Army named the airfield Roosevelt Field in honor of Quentin Roosevelt, a son of Theodore Roosevelt who had trained there and was killed during the war. After the war, the U.S. Air Service authorized aviation-related companies to operate from Roosevelt Field, but maintained control until July 1, 1920, at which time the Government sold its improvements on the airfield and relinquished control. The airfield reverted to use as a private airfield.

Roosevelt Field was used by the Navy and Army during World War II. In July 1939, the Army Air Corps contracted Roosevelt Field, Inc. to provide airplane and engine mechanics training to Army personnel at their school. In early 1941, there were more than 200 Army students and approximately 600 other students at the Roosevelt Aviation School. By March 1942, there were 6 steel/concrete hangars, 14 wooden hangars, and several other buildings at Roosevelt Field. The Army training school was concentrated in buildings located along Clinton Road. In addition to the training activities, the Roosevelt Field facilities were used to receive, refuel, crate, and ship Army aircraft.

In November 1942, the Navy Bureau of Aeronautics established a modification center at Roosevelt Field to install British equipment into U.S. aircraft for the British Royal Navy. The Navy leased five steel/concrete hangars along Old Country Road and built a barracks, mess hall, and sick bay and designated this installation as the U.S. Naval Air Facility Roosevelt Field. By September 1943, the Navy had built wooden buildings between four of the hangars, and in October 1943 leased six additional hangars. NAF Roosevelt Field was responsible for aircraft repair and maintenance, equipment installation, preparation and flight delivery of lend-lease aircraft, and metal work required for the installation of British modifications. The metal work constituted a substantial portion of the facility's work load. The facility also performed salvage work of crashed Royal Navy planes. The Navy vacated all but six hangars shortly after the war ended, and removed their temporary buildings by the time their lease expired on June 30, 1946. Restoration of buildings and grounds was completed by August 1946, and Roosevelt Field operated as a commercial airport until it closed in May 1951.

Soon after the airfield closed, the large Roosevelt Field Shopping Center was constructed at the site and opened in 1957. The old field is currently the site of the shopping mall and office building complexes, the Meadowbrook Parkway and is surrounded by commercial areas and light industry.

It is likely that chlorinated solvents were used at Roosevelt Field during and after World War II. Chlorinated solvents such as PCE and TCE have been widely used for aircraft manufacturing, maintenance, and repair operations since about the 1930s. Beginning in the late 1930s, the U.S. military issued protocols for use of solvents such as TCE for cleaning airplane parts and for de-icing. The types of airplanes designated for solvent use were present at Roosevelt Field during World War II. The finish specifications for at least one type of plane that the Navy modified at Roosevelt (eight of which were on site in April 1943) called for aluminum alloy to be cleaned with TCE. An aircraft engine overhaul manual issued in January 1945 specified TCE as a degreasing agent.

Wells 10 and 11 were installed by the Village of Garden City in 1952 and were put into service in 1953. Both wells have shown the presence of PCE and TCE since they were first sampled in the late 1970s and early 1980s, and concentrations increased significantly until 1987, when an air-stripping treatment system was installed to treat the water from the wells. The highest levels of VOC contamination were noted during the mid-to late 1990s, and have steadily declined since then, although the levels remain above EPA and New York State drinking water standards.

In addition to the Village of Garden City supply wells, seven cooling water wells in the mall area pumped contaminated groundwater from the Magothy aquifer for use in the air conditioning systems of the mall building and the office buildings west of the mall. These wells operated from approximately 1960 to 1985. After the contaminated groundwater was used in air conditioning systems, the untreated water was returned to the aquifer system via surface recharge, first to the Pembrook recharge basin and later to a drain field west of 100 Garden City Plaza and 200 Garden City Plaza.

The discharge of contaminated water into the recharge basin and drain field continued up to 1985 when the cooling water wells were taken out of service due to the presence of VOCs in the groundwater. Surface discharge of contaminated groundwater spread contamination through the Upper Glacial and Magothy aquifers. The recharge basin and drain field also created localized groundwater mounding, which may have spread contamination at the water table. The Pembrook recharge basin currently only receives surficial stormwater runoff from parking lots surrounding the mall and the office buildings. The drain field/diffusion wells near 100 Garden City Plaza are under the paved parking lot west of 100 Garden City Plaza and 200 Garden City Plaza and are not currently identifiable.

Remedial Investigation/Feasibility Study

A Remedial Investigation Report (CDM 2007a), Feasibility Study Report (CDM 2007b), and Record of Decision (ROD) (EPA 2007) have been completed for the site. Significant groundwater contamination from was identified at depth at SVP-4, which is located near the general area of the diffusion wells/drain field. The ROD designated remediation of an area of groundwater contaminated with chlorinated volatile organic compounds (VOCs), primarily tetrachloroethene (PCE) and trichloroethene (TCE).

The September 2007 ROD issued by EPA specified the following major remedial activities to address remediation of groundwater contamination at the site by a pump and treat system.

- <u>Pre-Design Investigation of the Contaminant Plume</u>: A pre-design investigation will be conducted to collect information for the remedial design. The pre-design investigation will include: installation of at least three multi-port monitoring wells; a pumping test; and infiltration tests at the Nassau County recharge basin #124.
- <u>Groundwater Modeling</u>: The preliminary three-dimensional groundwater model will be updated for the remedial design. Up-to-date contaminant distribution data will be collected from the pre-design investigation, and used to update the contaminant plume maps. The lithology and Site-specific hydraulic conductivity obtained during literature review and the pumping test will be incorporated into

the model. The improved groundwater model with up-to-date contaminant data will be used to select the final location(s) of groundwater extraction well(s) and discharge options for treated groundwater for the remedial design.

- Stage II Cultural Resource Survey: If ground intrusion such as well drilling or pipe routing are planned in any areas specified as sensitive for archeological resources during the Stage 1A cultural resource survey, a Stage II survey will be conducted.
- Groundwater Extraction Well: To reduce the contaminant concentrations reaching the two supply wells GWP-10 and GWP-11, a groundwater extraction well(s) will be installed south of SVP/GWM-4. A new remedial extraction well, SVP-4E, will capture the contaminant plume upgradient of SVP/GWM-4, while ensuring that the pumping capacity of supply wells GWP-10 and GWP-11 is not affected. The final location and number of extraction wells required will be determined after the pre-design investigation is completed and the groundwater model is updated.
- Ex-Situ Groundwater Treatment: A low profile air stripper will remove the volatile organic compound contaminants. During the remedial design, additional treatment technologies (including liquid phase carbon adsorption) may be considered if additional information suggests the need for treatment following air stripping. The treated water will meet groundwater and surface water discharge standards.
- Discharge of Treated Groundwater: The treated groundwater will be discharged to the local Nassau County recharge basin #124. During the remedial design, results of infiltration tests will be used to calculate the capacity of the recharge basin. Run-off from a representative rain event will also be calculated to verify the available capacity for treated groundwater discharge.

QAPP Worksheet #3
Distribution List

QAPP Recipients	Title	Organization	Telephone Number	Fax Number	E-mail Address
Fernando Rosado	Project Officer	EPA	(212) 637-4346	(212) 637-3966	rosado.fernando@epa.gov
Caroline Kwan	Remedial Project Manager (RPM)	EPA	(212) 637-4275	(212) 637-4284	Kwan.caroline@epa.gov
Angela Carpenter	Eastern New York Remediation Section Chief	EPA	(212) 637-4263	(212) 637-3966	carpenter.angela@epa.gov
Linda Mauel	Hazardous Waste Support Section Chief	EPA	(732) 321-6766	(732) 321-6622	mauel.linda@epa.gov
William Sy	QA Officer	EPA	(732) 632-4766	(212) 637-3966	sy.william@epa.gov
Sergion Lopez-Luna	QA Reviewer	EPA	(732) 321-6778	(732) 321-6622	Lopez.sergio@epa.gov
Heather Bishop	State Enforcement Manager	NYSDEC	(518) 402-9620	N/A	hlbishop@gw.dec.state.ny.us
Susan Schofield, PG	Site Manager (SM)	CDM	(203) 262-6633	(203) 262-6633	schofieldse@cdm.com
Jeanne Litwin, REM	RAC II Program Manager	CDM	(212) 377-4524	(212) 785-6114	litwinj@cdm.com
Jeniffer Oxford	Regional QA Coordinator (RQAC)/ Project QA Officer	CDM	(212) 377-4536	(212) 785-6114	oxfordjm@cdm.com
Lisa Campbell, PG	Pre-Design Task Manager (PDTM)	CDM	(212) 377-4055	(212) 785-6114	campbelll@cdm.com
Thomas Mathew, PE	Design Task Manager (DTM)	CDM	(732) 225-7000	(732) 225-6147	mathewt@cdm.com
Frank Tsang, PE	Senior Engineer	CDM	(212) 377-4056	(212) 785-6114	tsangc@cdm.com
Mike Ehnot	Field Team Leader (FTL)	CDM	(732) 225-7000	(732) 225-6147	ehnotm@cdm.com

QAPP Worksheet #4

Project Personnel Sign-Off Sheet

Organization: CDM

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Susan Schofield	Site Manager	(203) 262-6633		
Lisa Campbell	Pre-Design Task Manager	(212) 785-9123		
Mike Ehnot	Field Team Leader	(732) 225-7000		
Tonya Bennett	Field Geologist/Sampler	(212) 785-9123		
Mrutyunjay (Jay) Vajirkar	Geotechnical Engineer	(732) 225-7000		
Joe Button	Field Sampler	(212) 785-9123		
Tom Horn	Field Sampler	(732) 225-7000		
Melissa Koberle	Field Sampler	(212) 377-4530		
Dan O'Rourke	Groundwater Modeler	(732) 225-7000		

QAPP Worksheet #5
Project Organizational Chart

EPA Remedial Project Manager
Caroline Kwan

EPA QA Officer
William Sy

CDM QA Manager
Doug Updike

CDM Site Manager
Susan Schofield, PG

CDM Regional QA Coordinator/Project QA Officer
Jeniffer Oxford

Pre-Design Task Manager
Lisa Campbell, PG
Design Task Manager
Thomas Mathew, PE

CDM Health & Safety Manager
Shawn Oliveira

Subcontractors
- Drilling Services
- Surveying Services
- Cultural Resources
- IDW Disposal

Project Team
Project Engineer – Grace Chen, PE
Project Geologist – Lisa Campbell, PG
Field Team Leader – Mike Ehnot
Groundwater Modeler – Dan O'Rourke
Senior Engineer, Frank Tsang, PE
Field Geologists and Samplers, as needed

CDM Analytical Services Coordinator
Scott Kirchner

*** EPA CLP or DESA**

QAPP Worksheet #6
Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Point of Contact with EPA RPM	CDM SM	Susan Schofield	(203) 262-6633	All information about the project will be sent to Caroline Kwan by the SM. Field changes will be discussed with the EPA Remedial Project Manager (RPM) prior to implementation.
Manage Pre-Design Field Tasks	CDM PDTM	Lisa Campbell	(212) 785-9123	Act as liaison to SM concerning pre-design investigation activities. Daily communication with project team and SM. Communicate implementation issues to Field Team Leader.
Facilitate Database Setup and Data Management Planning	FTL	Mike Ehnot	(732) 225-7000	Provide sample location, sample ID, and analysis information prior to sample collection. Provide information on sample and analytical reporting groups, and types of report tables required for project.
QAPP Changes in the Field	FTL	Mike Ehnot	(732) 225-7000	Notify PDTM immediately and complete a Field Change Request (FCR) form and/or corrected worksheets. Send FCR forms to QAC.
	PDTM	Lisa Campbell	(212) 785-9123	Notify EPA RPM, CDM SM and Analytical Services Coordinator (ASC) of delays or changes to field work.
Completion of Daily Summary Reports	FTL	Mike Ehnot	(732) 225-7000	Complete on a daily basis and submit to SM and PDTM. SM will forward to EPA RPM upon request.
Booking of Analytical Services	FTL	Mike Ehnot	(732) 225-7000	Submit request to ASC before the timeframe below.
	Analytical Services Coordinator (ASC)	Scott Kirchner	(732) 225-7000	Book Division of Environmental Science and Assessment (DESA) and Contract Laboratory Program (CLP) analytical services through Regional Sample Control Center (RSCC) 3 weeks prior to sampling.

QAPP Worksheet #6
Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Notification of Analytical Issues	ASC	Scott Kirchner	(732) 225-7000	Notify FTL of any sample collection/ shipment issues. Notify RSCC, DESA lab or subcontract labs to initiate corrective action.
Field Corrective Action	CDM RQAC, auditor, PDTM, FTL, and Field Team	Mike Ehnot	(732) 225-7000	SM, PDTM, FTL, per QAR (quality assurance requirement). Corrective actions may also be identified by the field team. FTL initiates corrective action on identified field issues immediately or within RQAC recommended timeframe.
Analytical Services Support	ASC	Scott Kirchner	(732) 225-7000	Act as liaison with RSCC for CLP laboratories, with John Birri for DESA, and with subcontract laboratory(ies).
Facilitate Data Management	FTL	Mike Ehnot	(732) 225-7000	Provide electronic survey data, sample ID, locations and analyses. Transmit completed sample tracking information to data manager by the completion of each sampling case.
Reporting of Issues Relating to Analytical Data Quality (including ability to meet reporting limits, and usability of data)	ASC	Scott Kirchner	(732) 225-7000	Communicate to SM as appropriate
	Data Assessor	Scott Kirchner	(732) 225-7000	Communicate to SM as appropriate. Document situation and effect in a data quality report prepared prior to evaluation of remedial design report.
Release of Analytical Data	ASC	Scott Kirchner	(732) 225-7000	Receive and review data packages before data is used. Initiate data validation of subcontract laboratory data.
Site Health and Safety Issues	Site Health and Safety Officer	Mike Ehnot	(732) 225-7000	Conduct Daily Health and Safety Meetings, make decisions regarding health and safety issues and upgrading PPE. Communicate to SM, PDTM, HSM, and field staff as appropriate

QAPP Worksheet #7
Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Susan Schofield, PG	SM	CDM	Oversee project and responds to EPA RPM. Manages subcontractors.	B.S., M.S. Geology; P.G., over 25 years experience
Lisa Campbell, PG	PDTM	CDM	Provide technical expertise to the project team during the pre-design investigations	B.S. Geology; P.G.; 15 years experience in environmental investigations
Jeniffer Oxford	QA Coordinator/ Project Chemist	CDM	Oversee adherence to QA requirements	B.S., Natural Sciences; 7 years experience in analytical chemistry; 15 years experience in environmental science
Thomas Mathew, PE	DTM	CDM	Overseas Remedial Design Tasks	M.S., Water Resources Engineering; B.S. Civil Engineering; P.E.; BCEE;18 years experience in environmental engineering
Shawn Oliveira	Health and Safety Manager	CDM	Oversees adherence to Health and Safety requirements	B.S. Chemistry; M.S. Environmental Engineering; Certified Safety Professional No. 18988; 10 years experience
Scott Kirchner	ASC, Database Manager	CDM	Communicate with EPA RSCC, DESA laboratory and subcontract laboratories; oversee data management, validation and data packages.	B.S. Chemistry, Environmental Science Certified Hazardous Materials Manager, 19 years experience
Frank Tsang, PE	Senior Engineer	CDM	Provide technical expertise to the project team	B.S. Chemical Engineering; M.S. Chemical Engineering, P.E.; over 29 years of experience in engineering, design, construction, and project management
Grace Chen, PE	Project Engineer	CDM	Assist the Senior Engineer in implementing the RD activities.	M.S., B.S. Environmental Engineering; P.E.; 15 years experience in remedial design
Mike Ehnot	FTL Site H&S officer	CDM	Oversee all field investigation activities	B.A. Geology, 10 years experience in environmental consulting
Betty Krupka	GIS Specialist	CDM	Implement GIS databases in environmental planning	M.S., B.S. Environmental Science; 4 years of experience in GIS
Tonya Bennett	Field Geologist	CDM	Performs field investigations	B.S. Geology; 4 years field experience
Melissa Koberle	Field Sampler	CDM	Performs field investigations	B.S. Environmental Science, B.S. Biology, 2 years field experience.
Joe Button	Field Sampler	CDM	Performs field investigations	B.S. Geology, 6 years experience conducting environmental investigations

QAPP Worksheet #7
Personnel Responsibilities and Qualification Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Tom Horn	Field Sampler	CDM	Performs field investigations	B.A. Geography and Environmental Analysis; certificate in Wetland Delineation, over 20 years experience in environmental consulting
Mrutyunjay (Jay) Vijirkar	Geotechnical Engineer	CDM	Oversee geotechnical testing	B.S., Geotechnical Engineering, 6 years of geotechnical experience

QAPP Worksheet #8
Special Personnel Training Requirements Table

Project Function	Specialized Training	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
All Field Activities	40-hour Occupational Safety and Health Administration (OSHA) Training and Annual 8 hour refresher	40 hour - EPA or vendor; 8-hour web-based or CDM training and on-site safety briefings	various	All field team members	CDM staff, subcontractors	CDM Health and Safety (H&S) database and on site
All Field Activities	Site Supervisor Training	CDM H&S Manager	various	FTL, site H&S officer	FTL, site H&S officer	CDM H&S database and on site
Sample Collection	Trained in EPA Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sampling methods, Multi-port well installation and sampling procedures Field testing procedures	On-site training	various	CDM staff (Field samplers and geologists)	FTL, Geologists, field samplers	CDM
Sample Analysis	Trained in EPA analytical methods	Laboratory on-site and vendor training	various	Subcontract laboratory personnel - TBD	Laboratory personnel	Laboratory
Data Validation	Data validation Routine Analytical Services (RAS)	EPA	various	Data validators	Data Validators EPA, DESA	EPA
Data Review/ Assessment	None, performed by experienced chemists	CDM	various	CDM chemists	All personnel used for project data review	CDM

QAPP Worksheet #8
Special Personnel Training Requirements Table

Project Function	Specialized Training	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
QA Audits	EPA G-7 auditor training	CDM	various	CDM auditors	Jeniffer Oxford, RQAC and designated field auditors	CDM
Self Assessments (SA)	SA training	CDM QACs	various	project personnel	All project staff	CDM

QAPP Worksheet #9
Project Scoping Session Participants Sheet

Projected Date(s) of Sampling: 3/2008 – 6/2008 **Project Manager:** Susan Schofield		**Site Name:** Old Roosevelt Field Contaminated Groundwater Area Site **Site Location:** Garden City, New York		
Date of Session: 1/14/2008 **Scoping Session Purpose:** Discuss Remedial Design Work Plan				
Name	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
Susan Schofield	CDM	(203) 262-6633	schofieldse@cdm.com	Site Manager
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Comments/Decisions: Developed schedule for Draft Work Plan and Draft QAPP submittal

Action Items: (1) To complete and submit the Draft Work Plan in accordance with the scope provided by EPA on January 24, 2008. The scope includes:

- Perform pre-design investigations
- Complete remedial design

(2) Submit the Draft QAPP on January 31, 2008.

(3) Complete field investigations and provide EPA with pre-design data by July 5, 2008.

Consensus Decisions: Action items above were agreed to.

QAPP Worksheet #10
Problem Definition

Problem Summary

A Remedial Investigation (RI) Report (CDM 2007a), Feasibility Study (FS) report (CDM 2007b), and ROD (EPA 2007) have been completed for the Old Roosevelt Field Contaminated Groundwater Area Site (the site). The ROD identified an area of groundwater contaminated with chlorinated volatile organic compounds (VOCs), primarily tetrachloroethene (PCE) and trichloroethene (TCE). The ROD indicates that these contaminants exceed regulatory standards and are directly upgradient of two public supply wells and, therefore, must be remediated.

The September 2007 ROD issued by EPA specified the following major remedial activities to address groundwater contamination at the site:

- Pre-Design Investigation of the Contaminant Plume: A pre-design investigation will be conducted to collect information for the remedial design. The pre-design investigation will include: installation of at least three multi-port monitoring wells; a pumping test; and infiltration tests at the Nassau County recharge basin #124.
- Groundwater Modeling: The preliminary three-dimensional groundwater model will be updated for the remedial design. Up-to-date contaminant distribution data will be collected from the pre-design investigation, and used to update the contaminant plume maps. The lithology and Site-specific hydraulic conductivity obtained during literature review and the pumping test will be incorporated into the model. The improved groundwater model with up-to-date contaminant data will be used to select the final location(s) of groundwater extraction well(s) and discharge options for treated groundwater for the remedial design.
- Stage II Cultural Resource Survey: If ground intrusion such as well drilling or pipe routing are planned in any areas specified as sensitive for archeological resources during the Stage 1A cultural resource survey, a Stage II survey will be conducted.
- Groundwater Extraction Well: To reduce the contaminant concentrations reaching the two supply wells GWP-10 and GWP-11, a groundwater extraction well(s) will be installed south of SVP/GWM-4. A new remedial extraction well, SVP-4E, will capture the contaminant plume upgradient of SVP/GWM-4, while ensuring that the pumping capacity of supply wells GWP-10 and GWP-11 is not affected. The final location and number of extraction wells required will be determined after the pre-design investigation is completed and the groundwater model is updated.
- Ex-Situ Groundwater Treatment: A low profile air stripper will remove the volatile organic compound (VOC) contaminants. During the remedial design, additional treatment technologies (including liquid phase carbon adsorption) may be considered if additional information suggests the need for treatment following air stripping. The treated water will meet groundwater and surface water discharge standards.
- Discharge of Treated Groundwater: The treated groundwater will be discharged to the local Nassau County recharge basin #124. During the remedial design, results of infiltration tests will be used to calculate the capacity of the recharge basin. Run-off from a representative rain event will also be calculated to verify the available capacity for treated groundwater discharge.
- Evaluation and Upgrade of the Air Strippers at supply wells GWP-10 and GWP-11: An evaluation of the conditions of the air strippers will be conducted. Any necessary upgrade or replacement of the air strippers will be evaluated. The upgrade or replacement costs of the air strippers will be estimated based on the condition of the existing treatment system.
- Vapor Intrusion Sampling: There is concern, based on previous sampling results, that site-related vapor may migrate into the commercial buildings to the west of the mall. Vapor intrusion sampling will be conducted at six buildings during the winter heating season. Vapor mitigation systems will be installed, if further sampling indicates the need for such systems.
- Institutional Controls: Institutional controls will be relied upon to restrict the future use of groundwater at the site. Specifically, the New York State Department of Health State Sanitary Code regulates installation of private potable water supply wells in Nassau County. In addition, EPA will rely on the current zoning in the area including and surrounding the mall to restrict the land use to commercial industrial uses. If a change in land use

QAPP Worksheet #10
Problem Definition

is proposed, additional investigation of soils in this area will be necessary to support the land use change. Regulatory requirements under the State's Superfund program may result in NYSDEC seeking to obtain easements/covenants on various properties within the site.

- Site Management Plan: A SMP will be developed and will provide for the proper management of all Site remedy components post-construction, such as institutional controls, and shall also include: (a) monitoring of Site groundwater to ensure that, following remedy implementation, the groundwater quality improves; (b) conducting an evaluation of the potential for vapor intrusion, and mitigation, if necessary, in the event of future construction at or in the vicinity of the site; (c) provision for any operation and maintenance required of the components of the remedy; and (d) periodic certifications by the owner/operator or other person implementing the remedy that any institutional and engineering controls are in place.
- Long-term Monitoring: The contaminant plume will be monitored through annual sampling and analysis of groundwater. The results of the long-term monitoring program will be used to evaluate changes in the contaminant plume over time and to ensure achievement of MCLs.
- Contingency Plan: In the event that public supply wells GWP-10 and GWP-11 are taken out of service permanently or are operated at a significant reduction of their current pumping rates, a contingency plan would be implemented to capture and treat the contaminant plume in that area. The contingency plan would include the installation of a new well or wells in the vicinity of supply wells GWP-10 and GWP-11 and an ex-situ treatment system.

EPA work assignment #178 and this UFP-QAPP address only those activities needed to support the following pre-design and design activities:

- Refinement of the boundaries of the groundwater plume through installation of three multi-port wells
  - SVP-9 will be installed to define the northern boundary of the plume
  - SVP-10 will be installed to define the depth of contamination in the center of the plume
  - SVP-11 will be installed to determine if contamination migrates south (downgradient) of the Garden City supply wells #10 and 11
- Gamma logging of new wells
- Water level/port pressure measurements
- One round of monitoring well sampling at eight existing multi-port wells, three new multi-port wells (total of 95 ports), two supply wells, and two existing (single screen) monitoring wells
- Infiltration testing and soil for testing at Nassau County recharge basin No. 124
- Geotechnical soil testing/sampling at the treatment building location

The pre-design investigation at the site will include the installation of three multi-port wells to refine the northern and southern boundaries of the groundwater plume and the depth of contamination in the center of the plume. The new wells will be gamma logged prior to installation of outer casing/screens and Westbay multi-port systems. Water level/port pressure measurements will be taken at each well to be sampled (except the supply wells) prior to sampling. One round of monitoring well sampling will be conducted at eleven new/existing multi-port wells (95 ports), two supply wells, and two existing wells (10019 and 10020). Geotechnical borings will be drilled to support design of the treatment system building. Geotechnical borings and soil infiltration testing will be conducted to determine if the infiltration capacity of the existing basin is sufficient for the remedy.

Analytical data and field measurements are needed to support the Remedial Design including preparation of design drawings, specifications for the treatment, and installation of a groundwater extraction and treatment system at the site.

QAPP Worksheet #10
Problem Definition

Site Description
The information below briefly summarizes the characteristics of the site that are relevant to the pre-design investigation and the design of the groundwater remedy. Further information on the physical characteristics of the site, local demographics, site history, and nature and extent of contamination is provided in the following documents:

- Final Remedial Investigation Report (CDM 2007a)
- Final Feasibility Study (CDM 2007b)
- Record of Decision (EPA 2007)

The site is an area of groundwater contamination within the Village of Garden City, Town of Hempstead, located in central Nassau County, New York. Figures 1 and 2 provide a site location and a site map, respectively. The site is located on the eastern side of Clinton Road, south of the intersection with Old Country Road, and includes the area of the former Roosevelt Field airfield. The former Roosevelt Field airfield area is currently developed as a large retail shopping mall with a number of restaurants, and a movie theater. Several office buildings (including Garden City Plaza) are on the western perimeter of the mall and share parking space with the mall. A thin strip of open space along the eastern side of Clinton Road (known as Hazelhurst Park) serves as designated parkland and a buffer between the residential community on the west side of Clinton Road and the mall complex. Two recharge basins are directly south of the mall/office area. One basin is known as Pembrook Basin and is on property owned by the mall. The second basin is Nassau County Recharge Basin number 124. Two municipal supply well fields are located south (downgradient) of the former airfield: The Village of Garden City public supply wells 10 and 11, on the eastern side of Clinton Road. The Village of Hempstead Wellfield is located approximately 1 mile south of the Garden City supply wells.

Site History and Background
The site was used for aviation activities from 1911 to 1951. The original airfield was known as the Hempstead Plains Aerodrome and encompassed 900 to 1,000 acres east of Clinton Road and south of Old Country Road. By the time the field opened in July 1912, there were 5 cement and 30 wooden hangars along Old Country Road, 4 grandstands along Clinton Road, and several flying schools. At least two aviators built aircraft at the field in 1912, including the first all-metal monoplane in America. During its first three years, activities at the airfield included civilian flight training, equipment testing, and aerial stunt shows.

The United States (U. S.) military began using the Hempstead Plains field prior to World War I. The New York National Guard First Aero Company began training at the airfield in 1915, and in 1916 the U.S. Army used the field to train Army and Navy officers. When the U.S. entered World War I in April 1917, the airfield was taken over as a training center for military pilots and renamed Hazelhurst Field. The Army removed the grandstands, built barracks along Clinton Road, and built larger hangars along Old Country Road. In 1918, the Army changed the name of the airfield to Roosevelt Field in honor of Quentin Roosevelt, a son of Theodore Roosevelt who had trained there and was killed during the war. Roosevelt Field was used throughout the war to train aviators.

After the war, the U.S. Air Service authorized aviation-related companies to operate from Roosevelt Field, but maintained control until July 1, 1920, at which time the Government sold its improvements on the airfield and relinquished control of the field. Subsequently, the property owners sold portions along the southern edge of the field and split the remainder of the property into two flying fields with an incline between them. The eastern half, with

QAPP Worksheet #10
Problem Definition

sod runways and only two hangars, continued as Roosevelt Field. The western half, which had many hangars, flying schools, and aviation maintenance shops, became known as Curtiss Field.

By 1929, the eastern field (Roosevelt) had served as the starting point or terminus of many notable flights, including Lindbergh's takeoff for his historic trans-Atlantic flight in May 1927. The western field (Curtiss) was used for flying circuses, a flying school, aircraft sales and service, and flight tests. Both fields were bought in 1929 by Roosevelt Field, Inc., and the property was once again called Roosevelt Field. Improvements were quickly made, including the installation of several large steel and concrete buildings for hangars, shops, and office space along Old Country Road. As of November 1929, numerous aviation-related businesses operated in the hangars and other buildings surrounding the western field. By 1932, paved runways and 50 buildings made Roosevelt Field the country's largest and busiest civil airfield. While the western field developed into the large aviation center that continued to operate throughout the 1930s, the eastern field remained unpaved, with few buildings, until it was leased in 1935 and became a racetrack.

Roosevelt Field was used by the Navy and Army during World War II. In July 1939, the Army Air Corps contracted Roosevelt Field, Inc. to provide airplane and engine mechanics training to Army personnel at their school. In early 1941, there were more than 200 Army students and approximately 600 other students at the Roosevelt Aviation School. At the beginning of 1942, after the U.S. had entered the war, civilian flying and private hangar rental had ceased at Roosevelt Field due to a ban on private flying in defense areas.

As of March 1942, there were 6 steel/concrete hangars, 14 wooden hangars, and several other buildings at Roosevelt Field. The Army training school was concentrated in buildings located along Clinton Road. In addition to the training activities, the Roosevelt Field facilities were used to receive, refuel, crate, and ship Army aircraft.

The Navy also used Roosevelt Field during World War II. In November 1942, the Navy Bureau of Aeronautics established a modification center at Roosevelt Field to install British equipment into U.S. aircraft for the British Royal Navy. The Navy leased five steel/concrete hangars along Old Country Road and built a barracks, mess hall, and sick bay and designated this installation as the U.S. Naval Air Facility (NAF) Roosevelt Field by February 1943. By September 1943, the Navy had built wooden buildings between four of the hangars, and in October 1943 leased six additional hangars. NAF Roosevelt Field was responsible for aircraft repair and maintenance, equipment installation, preparation and flight delivery of lend-lease aircraft, and metal work required for the installation of British modifications. The metal work constituted a substantial portion of the facility's work load. The facility also performed salvage work of crashed Royal Navy planes. The Navy vacated all but six hangars shortly after the war ended, and removed their temporary buildings by the time their lease expired on June 30, 1946. Restoration of buildings and grounds was completed by August 1946, and Roosevelt Field operated as a commercial airport until it closed in May 1951.

Soon after the airfield closed, the large Roosevelt Field Shopping Center was constructed at the site and opened in 1957. The old field is currently the site of the shopping mall and office building complexes, the Meadowbrook Parkway and is surrounded by commercial areas and light industry. Three of the old Navy hangars remained standing until some time after June 1971, with various occupants, including a moving/storage firm, discotheque, amusement center, and bus garage.

QAPP Worksheet #10
Problem Definition

It is likely that chlorinated solvents were used at Roosevelt Field during and after World War II. Chlorinated solvents such as PCE and TCE have been widely used for aircraft manufacturing, maintenance, and repair operations since about the 1930s. Beginning in the late 1930s, the U.S. military issued protocols for use of solvents such as TCE for cleaning airplane parts and for de-icing. The types of airplanes designated for solvent use were present at Roosevelt Field during World War II. The finish specifications for at least one type of plane that the Navy modified at Roosevelt (eight of which were on site in April 1943) called for aluminum alloy to be cleaned with TCE. An aircraft engine overhaul manual issued in January 1945 specified TCE as a degreasing agent.

Wells 10 and 11 were installed by the Village of Garden City in 1952 and were put into service in 1953. Well 10 is screened from 377 to 417 feet below the ground surface (bgs) and well 11 is screened from 370 to 410 feet bgs. Both wells have shown the presence of PCE and TCE since they were first sampled in the late 1970s and early 1980s, and concentrations increased significantly until 1987, when an air-stripping treatment system was installed to treat the water from the wells. Sampling results of treated well water from May 1993, September 1995, and June/July 1999 indicated that breakthrough of the treatment system had occurred. The highest levels of VOC contamination were noted during the mid-to late 1990s, and have steadily declined since then, although the levels remain above EPA and New York State (NYS) drinking water standards.

In addition to the Village of Garden City supply wells, seven cooling water wells in the mall area pumped contaminated groundwater from the Magothy aquifer for use in the air conditioning systems of the mall building and the office buildings west of the mall. Cooling water wells pumped variable amounts of water, with greater extraction rates during the hot summer months. These wells operated from approximately 1960 to 1985. After the contaminated groundwater was used in air conditioning systems, the untreated water was returned to the aquifer system via surface recharge, first to the Pembrook recharge basin and later to a drain field west of 100 Garden City Plaza and 200 Garden City Plaza.

The discharge of contaminated water into the recharge basin and drain field continued up to 1985 when the cooling water wells were taken out of service due to the presence of VOCs in the groundwater. Surface discharge of contaminated groundwater spread contamination through the Upper Glacial and Magothy aquifers. The recharge basin and drain field also created localized groundwater mounding, which may have spread contamination at the water table. However, the sandy nature of the recharge basin soils likely did not result in retention of VOCs within the soils. In addition, the zone below the recharge basin has been flushed with stormwater runoff for 20 years; residual contamination from Roosevelt Field is not likely to remain in the area. The Pembrook recharge basin currently only receives surficial stormwater runoff from parking lots surrounding the mall and the office buildings. The drain field/diffusion wells near 100 Garden City Plaza are under the paved parking lot west of 100 Garden City Plaza and 200 Garden City Plaza and are not currently identifiable in the field. Significant groundwater contamination is present at depth at SVP/GWM-4, which is located near the general area of the diffusion wells/drain field.

Project Description
The objective of the pre-design investigation is to collect sufficient analytical data and field measurements to support the design of the groundwater extraction and treatment system. The pre-design investigation includes collection of chemical and physical data to refine the boundaries of the groundwater plume.

QAPP Worksheet #10
Problem Definition

The following major activities will be performed in support of the project objectives:

- Refinement of the boundaries of the groundwater plume through installation of three multi-port wells
  - SVP-9 will be installed to define the northern boundary of the plume
  - SVP-10 will be installed to define the depth of contamination in the center of the plume
  - SVP-11 will be installed to determine if contamination migrates south (downgradient) of the Garden City supply wells #10 and 11
- Gamma logging of new wells
- Water level/port pressure measurements
- One round of monitoring well sampling at eight existing multi-port wells, three new multi-port wells (total of 95 ports), two supply wells, and two existing (single screen) monitoring wells
- Infiltration testing and soil testing at Nassau County recharge basin No. 124
- Geotechnical soil testing/sampling at the treatment building location

Project Decision Conditions

- If the three new multi-port wells meet the project data requirements as defined in Worksheets #12, #17c, and #28, then no additional wells will be needed and the remedial design will proceed.
- If gamma logs indicate the presence of clay layers or lenses as defined in Worksheet #17c, then CDM will adjust the well screen locations to avoid placing screens in clay zones.
- If water level/port measurements meet the project data requirements defined in Worksheet #17e, then CDM will use the data to create new potentiometric maps showing groundwater flow.
- If the monitoring well sampling meets project data quality requirements defined in Worksheets #12, #17f, and #28, then CDM will prepare a Data Evaluation Report updating and refining the plume boundaries. Any significant changes in the plume boundary that may affect the remedial design will be discussed with EPA.
- If the results of the geotechnical borings meet the project data quality requirements defined in Worksheet #17g for design of the treatment system building, then CDM will proceed with the design of the treatment system building. Any soil boring results that may require changes in the building location will be discussed with EPA.
- If the results of the infiltration tests meet project data quality requirements defined in Worksheet #17g for the infiltration basin, then CDM will proceed with the design to use the basin to discharge effluent from the treatment plant.

QAPP Worksheet #11
Project Quality Objectives /Systematic Planning Process Statements

Who Will Use the Data?
EPA, NYSDEC, and CDM will use the data.

What Will the Data be Used For?

- To support the design of the groundwater extraction and treatment system
  - Confirm the configuration of the VOC plume that requires treatment
  - Confirm the levels of contamination that will need to be treated
  - Refine the boundaries of the VOC plume
  - Update the existing groundwater model so the most optimal number/screen interval/location of extraction wells can be determined
  - Allow finalization of the treatment train for the design
  - Support design of the treatment system building foundation
  - Confirm the infiltration capacity of Nassau County Recharge Basin No. 124 will be adequate for discharge of the treated effluent

What Type of Data are Needed?
The sampling program will include the following:

- Monitoring Well and Supply Well Sampling – 1) All ports/wells: Target Compound List (TCL) trace VOCs and field parameters (turbidity, temperature, oxidation-reduction potential (Eh), pH, dissolved oxygen, and specific conductance); 2) multi-port wells SVP-2, SVP-4, SVP-5, SVP-9, SVP-10: 3 samples per well (15 samples total): total iron, dissolved iron, total manganese, dissolved manganese, pH, hardness, and total suspended solids (TSS); 3) SVP-4 and the three new multi-port wells: Target Analyte List (TAL) metals – 1 port per well
- Treatment System Building Foundation Borings – Lithologic logging, grain size, moisture content, Atterberg limits
- Infiltration Basin Borings and Soil Infiltration Testing – Lithologic logging, grain size, soil infiltration slug testing
- Natural Gamma Logging – Downhole logging - natural gamma radiation
- Water Level/Port Pressure Measurements - Elevation of groundwater table and groundwater flow direction
- Continuous Water Level Measurements – Record water levels in existing well 10019 to determine preliminary aquifer characteristics based on water level changes from pumping supply wells

How "good" do the data need to be in order to support the environmental decision?
Definitive-level data are required to support the RD decisions for this project. The project-specific action limits and quantification limits for each sampled media are specified on Worksheet #15 for all the site-related contaminants. All laboratory analyses will be performed by EPA's Region 2 DESA laboratory, a CLP laboratory, or a CDM subcontract laboratory. CDM will comply with EPA's Field and Analytical Service Teaming Advisory Committee (FASTAC) policy for obtaining laboratory resources. Data must meet the data quality objectives (DQOs) that have been specified for the site.

QAPP Worksheet #11
Project Quality Objectives /Systematic Planning Process Statements

Where, when, and how should the data be collected?
Worksheet 16 presents the project schedule. The samples will be collected in the vicinity of the site, as indicated on Figures 3 and 4. Worksheet 17 presents the sampling program design and rationale. Worksheet 18 presents the sampling locations and methods. Worksheet 21 provides the SOPs that govern the various types of sampling.

Who will collect and generate the data?
CDM and subcontractors to CDM will collect the analytical samples that will be shipped to DESA, CLP, and/or CDM's subcontract labs for analysis. A drilling contractor will drill the boreholes, install monitoring wells and install the Westbay multi-port systems. CDM will collect the downhole gamma logging data, water level/port pressure measurements, and field measurements during groundwater sampling (dissolved oxygen [DO], pH, Eh, conductivity, temperature, and turbidity). A geotechnical contractor will log the infiltration basin and treatment system building foundation soil boring samples and will perform the soil infiltration tests. A licensed surveyor will survey the location and elevation of all wells and soil borings. A subcontractor will sample and dispose of investigation derived waste (IDW).

How will the data be reported?
Validated analytical data will be forwarded to CDM from DESA and/or CLP for evaluation and use in the remedial design and Data Evaluation Report. Analytical data generated by laboratories under subcontract to CDM will be received in electronic and hard copy and validated by CDM personnel. Following completion of all laboratory analysis and receipt of all electronic and hard-copy data, the data will be reported in the Remedial Design Report or Data Evaluation Report prepared by CDM. Data will be uploaded to Environmental Quality Information Systems (EQuIS). The database query and reporting tools will be used to create databases as specified by the project team. The reports will be submitted to EPA for review. CDM will use Geographic Information Systems (GIS) and other graphics software to facilitate spatial analysis of data and to generate figures for reports and presentations.

How will the data be archived?
- Preliminary data (Form 1s) will be faxed or e-mailed to CDM within the specified turnaround time.
- Data from CDM's subcontract laboratories will be received in electronic format specified in the contract and validated by CDM personnel.
- Final CLP validated data will be submitted to CDM in electronic format and hard copy consistent with CLP deliverables.
- Electronic data will be input into the project's database.
- Data packages will be assigned a unique document control number.
- EPA will archive CLP laboratory raw data in its document control system.
- Hard copies of field data including field log books and field data sheets will be archived in the project files.
- Hard copies of analytical data received by CDM will be archived in the project files for 10 years after contract expiration.

QAPP Worksheet #12a
Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group	TCL VOCs (Trace)				
Concentration Level	Low				
Sampling Procedure	**Analytical Method**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria[1] (MPC)**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Project-specific Low Flow SOP for Groundwater (App. A)	SOM01.2 trace water	Precision	RPD ≤ 50%[2] ABS ≤ 5xCRQL	Field Duplicates[3, 4]	S&A
		Accuracy/Bias	28-155%	Surrogate Spikes (DMC)	A
		Accuracy	≤ CRQLs[5]	Equipment Rinsate Blanks	S
		Accuracy	± 6 degrees Celsius[6]	Temperature Blank	S
		Sensitivity	≤ CRQLs[5]	Method Blank	A
		Completeness	≥ 90%	Data assessment	S&A
		Comparability	Similar Units (µg/L) Detection Limits meet project quantitation limit goals (PQLGs)[5]	Data Review - Compare results from each round	S&A

1. Analytical criteria are outlined in the CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWS and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where one result is detected and one is non-detect or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these measurement performance criteria (MPCs).
4. Under method SOM01.2, no matrix spike/matrix spike duplicate (MS/MSD) is required for VOCs.
5. See Worksheet # 15a for sensitivity requirements and CRQL values.
6. See Worksheet 28

SIM = Simultaneous Ion Monitoring

DMC = Deuterated Monitoring Compound

QAPP Worksheet #12b
Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group	TAL Metals				
Concentration Level	Low				
Sampling Procedure	**Analytical Method**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria[1]**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
- Samples from multi-port wells SVP-4, SVP-9, SVP-10 and SVP-11 (1 port per well) for full TAL Metals - 3 samples each from multi-port wells SVP-2, SVP-4, SVP-5, SVP-9, SVP-10 for total iron, dissolved iron, total manganese, dissolved manganese	ILM05.4 ICP-AES ICP-MS	Precision	RPD ≤ 50%[2] ABS ≤ 5xCRQL	Field Duplicates[3]	S&A
		Precision	RPD ≤ 40%	Laboratory Duplicates[4]	A
		Accuracy/Bias	75-125% recovery	Matrix Spikes	A
		Accuracy	≤ CRQLs[5]	Equipment Rinsate Blanks	S
		Accuracy/Bias	80–120%	Laboratory Control Samples	A
		Accuracy	± 6 degrees Celsius[6]	Temperature Blank	S
		Sensitivity	≤ CRQLs[5]	Method Blank	A
		Completeness	≥ 90%	Data assessment	S&A
		Comparability	Similar Units (μg/L) Detection Limits meet PQGLs[5]	Data Review - Compare results from each round	S&A

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWS and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where one result is detected and one is non-detect or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
4. Precision will be determined from the MS/MSD.
5. See Worksheet #15b for sensitivity requirements and CRQL values.
6. See Worksheet 28

ICP-AES = inductively coupled plasma-atomic emission spectroscopy
ICP-MS = inductively coupled plasma-mass spectroscopy

QAPP Worksheet #12c
Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group	Hardness, TSS				
Concentration Level	Low				
Sampling Procedure	**Analytical Method**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**[1]	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
3 samples each from multi-port wells SVP-2, SVP-4, SVP-5, SVP-9, SVP-10	Hardness - EPA 130.1/130.2 or ILM05.4 plus 200.7 with calculation TSS - EPA 160.2	Precision	RPD ≤ 50%[2] ABS 5xQL	Field Duplicates[3]	S&A
		Precision	RPD 40%	Analytical Replicates/ Duplicates[4]	A
		Accuracy/Bias	80-120%	LCS	S
		Accuracy	± 6 degrees Celsius[6]	Temperature Blank	S
		Sensitivity	QLs[5]	Method Blank	A
		Completeness	90%	Data Assessment	S&A
		Comparability	Similar Units (mg/L) Detection Limits meet PQGLs[5]	Data Review - Compare results from each round	S&A

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWS and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where one result is detected and one is non-detect or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
4. Precision will be determined from the laboratory duplicate results.
5. See Worksheet # 15c for sensitivity requirements and QL values.
6. See Worksheet 28

QAPP Worksheet #12d
Measurement Performance Criteria Table

Matrix	Soil
Analytical Group	Grain size
Concentration Level	Low

Sampling Procedure	**Analytical Method**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**[1]	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
TSOP 1-4 Subsurface Soil Sampling	Grain size-ASTM D421-85 & D422-63	Precision	RPD 100%[2] ABS 5xQL	Field Duplicates [3]	S&A
		Precision	RPD +/- 40%	Laboratory Duplicates	A
		Accuracy/Bias	75-125% recovery	N/A	N/A
		Accuracy/Bias	80-120% recovery	N/A	N/A
		Accuracy	± 6 degrees Celsius[4]	Temperature Blank	S
		Sensitivity	CRQLs	N/A	N/A
		Completeness	90%	Data Assessment	S&A
		Comparability	Units mg/kg - Detection Limits meet PQGLs	Data Review - Compare results from each round	S&A

1. Note: Grain size will be analyzed by the drilling subcontractor's geotechnical specialist laboratory or by a low tier geotechnical subcontractor.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where one result is detected and one is non-detect or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils. Data qualifiers will be applied to the field duplicate samples only.
4. See Worksheet 28d

N/A = not applicable

QAPP Worksheet #12e
Measurement Performance Criteria Table

Matrix	Aqueous
Analytical Group	In-Field Measurements
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Project-specific Low Flow SOP for Groundwater (App. A)	NA	Representativeness	± 0.1	pH (standard units)	S&A
			± 3%	Conductivity (µSiemens)	S&A
			± 10 mV	Redox Potential (Eh) (millivolts)	S&A
			± 10%	Turbidity	S&A
			± 10%	Dissolved Oxygen	S&A
			Flow rate	Monitored in the field (see Low Flow TSOP for flow rate criteria)	S&A

NA = Not Applicable

QAPP Worksheet #13
Secondary Data Criteria and Limitations Table

Secondary Data	Data Generator(s) (Originating Org., Data Types, Data Generation/ Collection Dates)	Data Source (Originating Organization, Report Title, and Date)	How Data Will Be Used	Limitations on Data Use
Data Collected during remedial investigation	CLP data, DESA data, Katahdin subcontract laboratory; Data collected in 2005 and 2006.	Remedial Investigation Report	To help define the groundwater plume	None – data have been validated.

QAPP Worksheet #14
Summary of Project Tasks

Sampling Tasks: Sampling tasks are summarized below:

Groundwater

- Monitoring Well Groundwater Samples (See Figure 3)
  - Samples from 8 existing multi-port wells (65 ports), 3 new multi-port wells (30 ports), 2 supply wells, and 2 single-screen monitoring wells (10019 and 10020)
  - 95 ports, 2 monitoring wells utilizing low flow sampling methods, and 2 supply wells sampled from a tap
  - 99 total samples
  - Analyses: All samples: Trace VOCs; multi-port wells SVP-2, SVP-4, SVP-5, SVP-9, SVP-10: 3 samples per well (15 total): total iron, dissolved iron, total manganese, dissolved manganese, pH, hardness, TSS; SVP-4 and the three new multi-port wells: TAL metals only – 1 port per well

Soil

- Building Foundation Geotechnical Soil Samples (see Figure 4)
  - 2 locations, 1 event
  - 4 samples per soil boring for grain size and moisture content, 1 sample per soil boring for Atterberg limits (only if clayey soils are encountered)
  - 8 total grain size and moisture content, 2 Atterberg limits total
- Recharge Basin Geotechnical Soil Samples (see Figure 4)
  - 4 locations, 1 event
  - 7 samples per soil boring
  - 28 total samples

Quality Control Tasks:
Soil and water will have one or more of the following QC samples analyzed: field duplicates, matrix spike/matrix spike duplicates, trip blanks, rinsate blanks, reagent water blanks, and all other QA/QC samples as defined in the method.

Secondary Data:
The RI data will be used along with the pre-design data to achieve project objectives.

Data Management Tasks:
Analytical data will be imported into the EQuIS database after validation. Field measurements will also be added to the database. Typical data management tasks are outlined in TSOP 4-8; Roosevelt's Environmental Data Management will follow the procedures described in Appendix E.

Documentation and Records:
All sample locations will be surveyed. Information regarding samples will be recorded in site logbooks in accordance with TSOP 4-1, field logbook content and control. Documents will be maintained in the project files and/or the RAC II document control system. A document control number will be assigned to all project deliverables.

Volatile Organic Compounds	CAS Number	Project Action Limit (µg/L)[1,2]	Project Quantitation Limit Goal (µg/L)	Analytical Method[3]			Achievable Laboratory Limits	
				MDLs	CRQLs µg/L	Option	MDLs	QLs
1,1,1-Trichloroethane	71-55-6	5	1	N/A	0.5	Trace	N/A	N/A
1,1,2,2-Tetrachloroethane	79-34-5	5	1	N/A	0.5	Trace	N/A	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	5	1	N/A	0.5	Trace	N/A	N/A
1,1,2-Trichloroethane	79-00-5	1	1	N/A	0.5	Trace	N/A	N/A
1,1-Dichloroethane	75-34-3	5	1	N/A	0.5	Trace	N/A	N/A
1,1-Dichloroethylene	75-35-4	5	1	N/A	0.5	Trace	N/A	N/A
1,2,3-Trichlorobenzene	87-61-6	5	1	N/A	0.5	Trace	N/A	N/A
1,2,4-Trichlorobenzene	120-82-1	5	1	N/A	0.5	Trace	N/A	N/A
1,2-Dibromo-3-chloropropane	96-12-8	0.5	0.5	N/A	0.5	Trace	N/A	N/A
1,2-Dibromoethane	106-93-4	NL	N/A	N/A	0.5	Trace	N/A	N/A
1,2-Dichlorobenzene	95-50-1	3	1	N/A	0.5	Trace	N/A	N/A
1,2-Dichloroethane	107-06-2	0.6	0.1	N/A	0.5	Trace	N/A	N/A
1,2-Dichloropropane	78-87-5	1	0.2	N/A	0.5	Trace	N/A	N/A
1,3-Dichlorobenzene	541-73-1	3	1	N/A	0.5	Trace	N/A	N/A
1,4-Dichlorobenzene	106-46-7	3	1	N/A	0.5	Trace	N/A	N/A
2-Butanone	78-93-3	NL	N/A	N/A	5	Trace	N/A	N/A
2-Hexanone	591-78-6	NL	N/A	N/A	5	Trace	N/A	N/A
4-Methyl-2-pentanone	108-10-1	NL	N/A	N/A	5	Trace	N/A	N/A
Acetone	67-64-1	NL	N/A	N/A	5	Trace	N/A	N/A
Benzene	71-43-2	1	0.2	N/A	0.5	Trace	N/A	N/A
Bromochloromethane	74-97-5	5	1	N/A	0.5	Trace	N/A	N/A
Bromodichloromethane	75-27-4	5	1	N/A	0.5	Trace	N/A	N/A
Bromoform	75-25-2	NL	N/A	N/A	0.5	Trace	N/A	N/A
Bromomethane	74-83-9	5	1	N/A	0.5	Trace	N/A	N/A
Carbon Disulfide	75-15-0	NL	N/A	N/A	0.5	Trace	N/A	N/A
Carbon Tetrachloride	56-23-5	5	1	N/A	0.5	Trace	N/A	N/A
Chlorobenzene	108-90-7	5	1	N/A	0.5	Trace	N/A	N/A
Chloroethane	75-00-3	5	1	N/A	0.5	Trace	N/A	N/A
Chloroform	67-66-3	7	1	N/A	0.5	Trace	N/A	N/A
Chloromethane	74-87-3	NL	N/A	N/A	0.5	Trace	N/A	N/A
cis-1,2-Dichloroethene	156-59-2	5	1	N/A	0.5	Trace	N/A	N/A
cis-1,3-Dichloropropene	10061-01-5	NL	N/A	N/A	0.5	Trace	N/A	N/A
Cyclohexane	110-82-7	NL	N/A	N/A	0.5	Trace	N/A	N/A
Dibromochloromethane	124-48-1	5	1	N/A	0.5	Trace	N/A	N/A
Dichlorodifluoromethane	75-71-8	5	1	N/A	0.5	Trace	N/A	N/A
Ethylbenzene	100-41-4	5	1	N/A	0.5	Trace	N/A	N/A
Isopropylbenzene	98-82-8	5	1	N/A	0.5	Trace	N/A	N/A
Methyl Acetate	79-20-9	NL	N/A	N/A	0.5	Trace	N/A	N/A

Volatile Organic Compounds	CAS Number	Project Action Limit (µg/L)[1,2]	Project Quantitation Limit Goal (µg/L)	Analytical Method[3]			Achievable Laboratory Limits	
				MDLs	CRQLs µg/L	Option	MDLs	QLs
Methyl Tert-Butyl Ether	1634-04-4	NL	N/A	N/A	0.5	Trace	N/A	N/A
Methylcyclohexane	108-87-2	NL	N/A	N/A	0.5	Trace	N/A	N/A
Methylene Chloride	75-09-2	5	1	N/A	0.5	Trace	N/A	N/A
m-Xylene [4]	1330-20-7	5	1	N/A	0.5	Trace	N/A	N/A
o-Xylene	1330-20-7	5	1	N/A	0.5	Trace	N/A	N/A
p-Xylene [4]	1330-20-7	5	1	N/A	0.5	Trace	N/A	N/A
Styrene	100-42-5	5	1	N/A	0.5	Trace	N/A	N/A
Tetrachloroethene	127-18-4	5	1	N/A	0.5	Trace	N/A	N/A
Toluene	108-88-3	5	1	N/A	0.5	Trace	N/A	N/A
trans-1,2-Dichloroethene	156-60-5	5	1	N/A	0.5	Trace	N/A	N/A
trans-1,3-Dichloropropene	10061-02-6	0.5	0.5	N/A	0.5	Trace	N/A	N/A
Trichloroethene	79-01-6	5	1	N/A	0.5	Trace	N/A	N/A
Trichlorofluoromethane	75-69-4	5	1	N/A	0.5	Trace	N/A	N/A
Vinyl Chloride	75-01-4	2	1	N/A	0.5	Trace	N/A	N/A
Xylenes (total)	1330-20-7	5	1	N/A	0.5	Trace	N/A	N/A

Contaminants of concern: Trichloroethene, tetrachloroethene, 1,1-dichloroethylene, cis-1,2-dichloroethene

Notes

1. EPA National Primary Drinking Water Standards (NPDWS) (web page), EPA 816-F-03-016 June 2003.
2. NYSDEC Surface and Groundwater Quality Standards March 28, 2003, 6 NYCRR Chapter X Part 703.

The criteria used for the Project Action Limit is the lower value of 1. and 2.

3. SOM01.2 trace water method.
4. m-Xylene and p-xylene reported as one compound under S0M01.2.
5. Site related contaminants are highlighted.

CRQL = Contract Required Quantitation Limit
MDL = method detection limit
NA = Chemical name listed but no value available
N/A = Not Applicable
PAL= Project Action Limit.
PQLG = Project Quantitation Limit Goal.
µg/L = micrograms per liter
NYSDEC = New York State Department of Environmental Conservation
NYCRR = New York Codes, Rules and Regulations
NL = Not Listed

QAPP Worksheet # 15b
Reference Limits and Evaluation Table - Groundwater

Inorganic Analytes	CAS Number	Project Action Limit (µg/L) [1,2]	Project Quantitation Limit Goal (µg/L)	Analytical Method MDLs	Analytical Method CRQLs (µg/L)	Analytical Method Option	Achievable Laboratory Limits MDLs	Achievable Laboratory Limits QLs
Aluminum	7429-90-5	NL	N/A	N/A	200	ICP-AES	N/A	N/A
Antimony	7440-36-0	3	2	N/A	2	ICP-MS	N/A	N/A
Arsenic	7440-38-2	10	2	N/A	1	ICP-MS	N/A	N/A
Barium	7440-39-3	1000	200	N/A	200	ICP-AES	N/A	N/A
Beryllium	7440-41-7	4	1	N/A	1	ICP-MS	N/A	N/A
Cadmium	7440-43-9	5	1	N/A	1	ICP-MS	N/A	N/A
Calcium	7440-70-2	NL		N/A	5000	ICP-AES	N/A	N/A
Chromium	7440-47-3	50	10	N/A	10	ICP-AES	N/A	N/A
Cobalt	7440-48-4	NL	N/A	N/A	5	ICP-AES	N/A	N/A
Copper	7440-50-8	200	40	N/A	25	ICP-AES	N/A	N/A
Cyanide	57-12-5	200	40	N/A	10	ICP-AES	N/A	N/A
Iron	7439-89-6	300	100	N/A	100	ICP-AES	N/A	N/A
Lead	7439-92-1	15	3	N/A	1	ICP-AES	N/A	N/A
Magnesium	7439-95-4	NL	N/A	N/A	5000	ICP-AES	N/A	N/A
Manganese	7439-96-5	300	60	N/A	15	ICP-AES	N/A	N/A
Mercury	7439-97-6	0.7	0.2	N/A	0.2	ICP-AES	N/A	N/A
Nickel	7440-02-0	100	40	N/A	40	ICP-AES	N/A	N/A
Potassium	7440-09-7	NL	N/A	N/A	5000	ICP-AES	N/A	N/A
Selenium	7782-49-2	10	5	N/A	5	ICP-MS	N/A	N/A
Silver	7440-22-4	50	10	N/A	10	ICP-AES	N/A	N/A
Sodium	7440-23-5	20,000	5000	N/A	5000	ICP-AES	N/A	N/A
Thallium	7440-28-0	2	1	N/A	1	ICP-MS	N/A	N/A
Titanium	7440-32-6	NL	N/A	N/A	NL	ICP-MS	N/A	N/A
Vanadium	7440-62-2	NL	N/A	N/A	50	ICP-AES	N/A	N/A
Zinc	7440-66-6	NL	N/A	N/A	60	ICP-AES	N/A	N/A

QAPP Worksheet # 15b
Reference Limits and Evaluation Table - Groundwater

Notes

1. EPA Source National Primary Drinking Water Standards (NPDWS) (web page), EPA 816-F-03-016 June 2003.
2. NYSDEC Surface and Groundater Quality Standards March 28, 2003, 6 NYCRR Chapter X Part 703

The criteria used for the Project Action Limit is the lower value of 1. and 2.

CRQL - contract required quantitation limit
MDL - method detection limit
N/A - Not Applicable
NL - Chemical name not listed or screening value of this type not listed for the chemical
µg/L - micrograms per liter

QAPP Worksheet # 15c
Reference Limits and Evaluation Table- Groundwater

Water Quality Compounds	CAS Number	Project Action Limit (mg/L)	Project Quantitation Limit Goal (mg/L)	Analytical Method			Achievable Laboratory Limits	
				MDLs[1]	Typical Quantitation Limits	Option	MDLs	QLs
Hardness	N/A	N/A	1.0	N/A	1 mg/L	N/A	TBD	TBD
TSS	N/A	N/A	4.0	N/A	4.0 mg/L	N/A	TBD	TBD

Notes
1. MDLs are not defined in these methods. The DESA request or laboratory SOW will include the PQLGs in order to achieve the requested limits.

mg/L = milligrams per liter
MDL = method detection limit
N/A = Not applicable
TBD = to be determined
TSS = total suspended solids

QAPP Worksheets 15d
Reference Limits and Evaluation Table - Soil

Analysis	CAS Number	Project Action Limit (µg/L)	Project Quantitation Limit Goal (µg/L)	Analytical Method			Achievable Laboratory Limits	
				MDLs	CRQLs (µg/L)	Option	MDLs	QLs
Grain Size	N/A	N/A	N/A	N/A	N/A	N/A	TBD	TBD
Moisture	N/A	N/A	N/A	N/A	+/- 0.5 units	N/A	TBD	TBD
Atterberg Limit	N/A	N/A	N/A	N/A	N/A	N/A	TBD	TBD

Notes
CRQL = Contract Required Quantitation Limit
MDL = method detection limit
N/A = Not applicable
TBD = to be determined
µg/L = micrograms per liter

QAPP Worksheet #16
Project Schedule Timeline Table

Figure 5 Presents the Project Schedule

QAPP Worksheet # 17
Sampling Design and Rationale

The RD field investigations include refining the extent of the groundwater plume, and the design and implementation of a groundwater extraction and treatment system at the site. The purpose of the RD investigation is to use the sampling data to obtain information necessary to design of the treatment facility building, the extraction well system, and the piping to the recharge basin.

The major elements of the field investigation for the RD include:

- Multi-port monitoring well installation to further refine the groundwater plume
- Gamma logging of wells
- Collection of samples for geotechnical characterization of the building area
- Percolation testing at the recharge basin and grain size analysis of soils
- Continuous water level measurements at monitoring well 10019
- Collection of one round of groundwater samples from 11 multi-port monitoring wells, 2 supply wells, and 2 single-screen wells
- Synoptic water level/port pressure measurements taken in conjunction with the round of monitoring well sampling

The field program will include:

- Mobilization and Demobilization **(Worksheet 17a)**
- Site Reconnaissance **(Worksheet 17b)**
- Hydrogeological Assessment
  - Multi-port Monitoring Well Installation **(Worksheet 17c)**
  - Gamma Logging **(Worksheet 17c)**
  - Continuous Water Level Measurements **(Worksheet 17d)**
  - Synoptic Water Level/port Pressure Measurements **(Worksheet 17e)**
- Groundwater Sampling **(Worksheet 17f)**
- Geotechnical Investigation **(Worksheet 17g)**
- Decontamination Procedures **(Worksheet 17h)**

QAPP Worksheet # 17a
Sampling Design and Rationale
Mobilization and Demobilization

Site Preparation and Restoration

CDM will visually inspect drilling areas for the presence of overhead utilities and surface features that could limit the mobility or use of a drill rig at the proposed locations. The drilling subcontractor will be responsible for contacting an appropriate utility location service to locate and mark out underground utilities. The drilling subcontractor will be responsible for clearing vegetation, if necessary. CDM will direct and oversee any necessary clearing activities conducted by the drilling subcontractor.

Health and safety work zones including personnel decontamination areas will be established at the beginning of each field activity in accordance with the site-specific HASP. Local authorities such as the police and fire departments will be notified prior to the start of field activities.

Some field activities are expected to occur on private and public properties. In the event that property damage occurs on and around these properties (e.g., landscaping and paving) as a result of the proper performance of field investigation activities, such damages will be restored, as near as practicable, to the conditions existing immediately prior to such activities. CDM will maintain photographic documentation of site conditions prior to commencement of and after completion of the field activities.

At the completion of the field activities, decontamination pad materials will be decontaminated and removed from the decontamination area, unless otherwise instructed by EPA. The decontamination and command post area will be restored, as near as practicable, to its original condition.
It is anticipated that one mobilization will be required at the beginning of the field investigation and one demobilization event will be required at the conclusion of the field investigation.

Access Support

Access to public areas and private property will be needed to execute the field investigation. EPA will be responsible for obtaining site access. CDM will assist EPA with site access. Access support is anticipated for the monitoring well installation, recharge basin testing, and geotechnical soil sampling. CDM will provide a list of property owners (public and private) to be accessed during the field activities. The list will include the mailing address and telephone number of the property owners. Once EPA has established that access has been granted, monitoring well installation can begin. CDM will contact and coordinate with property owners and local officials (for work in public areas) to schedule sampling activities.

Field Planning Meetings

Prior to performing the pre-design field activities, each field team member will review all project plans and participate in a field planning meeting conducted by the CDM SM and FTM to become familiar with the history of the site, health and safety requirements, quality control requirements, field procedures, tasks to be performed, and communication requirements. All new field personnel will receive a comparable briefing if they do not attend the initial field planning meeting and/or the tailgate kick-off meeting. Supplemental meetings may be conducted as required by any changes in site conditions or to review field operation procedures.

QAPP Worksheet # 17a
Sampling Design and Rationale
Mobilization and Demobilization

Field Equipment and Supplies
Equipment and field supply mobilization, governed by CDM's Quality Procedures section 2.1 *Procuring Measurement and Test Equipment* and section 5.3 *Equipment Inspection*, will entail ordering, renting, and purchasing all equipment and supplies needed for each part of the pre-design field investigation. This will also include staging and transferring all equipment and supplies to and from the site. Measurement and Test Equipment forms will be completed for rental or purchase of equipment (instruments) that will be utilized to collect field measurements. The field equipment will be inspected for acceptability, and instruments calibrated as required prior to use. This task also involves the construction of a decontamination area for sampling equipment and personnel. A separate decontamination pad will be constructed by the drilling subcontractor for drilling equipment.

Field Trailer, Utilities, and Services
Arrangements for the lease of a field trailer and associated utilities (telephone, data line, and electricity), a secure storage area for IDW, trash containers, and portable sanitary facilities will be made. CDM assumes that the field support area set up will be the same as for the RI with the support trailer, trash container and portable sanitation located within the fenced compound at the Garden City supply wells. The project support area will be located in the compound and contain a decontamination pad, drilling equipment and supplies, a 21,000-gallon liquid waste storage tank, and one 20 cubic yard (CY) roll-off for drilling cuttings and mud storage.

Equipment will be demobilized at the completion of the field event, as necessary. Demobilized equipment will include sampling equipment, drilling subcontractor equipment, health and safety equipment, and decontamination equipment.

Investigation Derived Waste (IDW)
A subcontractor will be procured who will be responsible for the removal and proper disposal of all IDW, including purge water, drilling cuttings, drilling mud, waste soils, solids, and personal protective equipment (PPE) in accordance with all Federal, state, and local regulations and in accordance with subcontract requirements and the QAPP. Drill cuttings and water from drilling operations will be containerized at the drilling location and transported by the drilling subcontractor to a central waste storage area. Liquid wastes will be transferred to a 21,000-gallon Baker tank, and drill mud and cuttings will be transferred into 20-CY roll-off containers. The roll-off containers will be capable of separating the liquid and sludge fractions of the drilling mud; the liquid fraction will then be transferred to the 21,000 gallon liquid storage tank. Waste samples will be collected and analyzed by a laboratory to characterize the waste. A technical statement of work will be prepared for the procurement of the waste hauling and disposal subcontractor. Field oversight and health and safety monitoring will be conducted during all waste disposal field activities.

Field procedures for this activity are detailed in TSOP 2-2: Guide to Handling Investigation Derived Waste.

QAPP Worksheet # 17b
Sampling Design and Rationale
Site Reconnaissance

Site Reconnaissance
Site reconnaissance activities will be performed to support mobilization and to prepare for drilling and sampling activities. During the site reconnaissance, sample locations will be identified and marked, property boundaries and utility rights-of-way will be located, utility mark outs will be completed by CDM's drilling subcontractor, and photographs will be taken.

The following reconnaissance activities are required to support the field activities:
- Identify and mark final locations for three multi-port monitoring wells
- Identify and mark testing locations in recharge basin
- Identify and mark geotechnical boring locations

Drilling/Testing Reconnaissance
Prior to installing monitoring wells, the recharge basin testing, and the geotechnical borings, the field team will visit proposed locations to identify and mark exact drilling locations and assess potential logistical issues and physical access constraints for the drill rig. Potential problem locations will be documented and photographed and locations may be adjusted to facilitate access. Because many of the work sites are located on private property or in commercial areas, it is anticipated that close coordination will be required with local authorities and police regarding access and safety issues.

Topographic Survey Oversight
The existing topographic map and geographic information system (GIS) database and maps prepared during the RI/FS will be used for this project. The coordinates of all additional sampling locations will be surveyed and added to the existing GIS and topographic maps. The additional sampling locations include monitoring wells, recharge basin testing, and geotechnical soil borings. Three elevations will be determined at each monitoring well: the ground surface, the top of the inner casing, and the top of the outer casing. A topographic survey of the recharge basin and the treatment plant area will be conducted, with 2-foot contours in the overall area, and 1-foot contours along the route for the pipeline.

Field Procedures for these Activities are detailed in:
- TSOP 3-2 Topographic Survey
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation

QAPP Worksheet # 17c
Sampling Design and Rationale
Multi-port Monitoring Well Installation

Multi-port Monitoring Well Drilling

Three multi-port monitoring wells will be installed during the pre-design investigation, including: SVP-9 (north of SVP-4), SVP-11 (south of the two Garden City supply wells), and SVP-10 (approximately 100 feet south of SVP-4). Figure 3 shows the proposed locations of new multi-port monitoring wells. Proposed well depths and screen intervals are provided in Table 1. Each of the three new multi-port wells will have 10 sampling ports. The screen intervals/sampling port elevations are comparable to those in the existing multi-port wells.

It is anticipated that monitoring wells will be installed using the mud rotary drilling methods. An eight-inch diameter borehole will be advanced to the target depth (approximately 500 feet). Five-foot long well screens (10 per location) will be installed at the selected intervals shown in Table 1.

Outer screen/casing assemblies will be constructed of 4-inch diameter Schedule 10 stainless steel casing. In accordance with EPA Region 2 low-flow, minimal drawdown sampling protocols, the screens will be five-foot lengths of slotted stainless steel screen size 0.01 inch (10-slot). Wells will be single-cased. A 10-foot sump (4-inch diameter stainless steel casing with end cap) will be added below the bottom of the deepest screen interval in order to accommodate the sample containers during sampling. All joints will be flush-threaded. The annulus around the well screen will be backfilled with #01 filter pack sand, which will extend two feet below and two feet above the well screen. Bentonite sand slurry will fill the annulus between the sand filter pack surrounding each screen. After the slurry is installed above the last sand pack interval, the remaining annulus will be filled to the ground surface with a cement-bentonite grout installed by the tremie method. An eight-inch steel protective casing with a locking cap will be installed and a concrete collar will be poured around the well. All wells will be completed flush with the ground surface. An identification number plate will be painted on the outside of the protective casing. Field procedures for well drilling and construction are described in TSOP 4-4.

Natural Gamma Logging

After drilling but before completion of the well bores with the screens/casing, natural gamma logs will be run in each well to provide lithologic data to refine screen interval placement. The gamma logs will be correlated with the lithologic data collected during the RI. Gamma logging will be performed by CDM personnel in accordance with TSOP 3-4 and the manufacturer's instructions.

Development

Monitoring well installation will not be considered complete until the screen intervals in the outer screen/casing assemblies have been fully developed. Development will be performed to remove drilling mud, silt and well construction materials from the screen intervals and sand pack and to provide a good hydraulic connection between the well and the aquifer materials. Turbidity, pH, temperature, conductivity, and dissolved oxygen will be monitored during development. Development will continue until all parameters have stabilized (within 10 percent for successive measurements) and the water is clear or is as clear as can be achieved for the local conditions. Field procedures for well drilling and construction are described in TSOP 4-3. CDM will attempt to meet the 5 Nephelometric Turbidity Units (NTU) guidance value for turbidity; however, it is often impractical to achieve such low turbidity during well development. Consequently, well development will be considered complete when turbidity has decreased to a relatively static level (measurements within a 10 percent range).

QAPP Worksheet # 17c
Sampling Design and Rationale
Multi-port Monitoring Well Installation

Multi-port Well Equipment Installation

Each multi-port well will be installed inside the 4-inch diameter, stainless steel casing/screen assembly. The Westbay system will be used for the multi-port wells. All multi-port well components will be supplied by the drilling subcontractor through a lower tier subcontract with Westbay. The drilling subcontract will require that the driller receive installation training from Westbay prior to completion of the multi-port wells. The drilling subcontractor and Westbay will be responsible for installation of the Westbay equipment in each newly installed outer casing/screen assembly.

Field Procedures for these Activities are detailed in:

- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 3-4 Geophysical Logging, Calibration, and Quality Control
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-3 Well Development and Purging, with a RAC II clarification, Section 5.3 Indicator Parameter Method of Well Purging
- TSOP 4-4 Design and Installation of Monitoring Wells in Aquifers (Mud Rotary Drilling)
- Worksheet 17h Decontamination Procedures

QAPP Worksheet # 17d
Sampling Design and Rationale
Continuous Water Level Measurements

Continuous water level measurements will be collected for approximately one month at single screen monitoring well 10019. Water level and barometric pressure readings will be measured using an In-situ TROLL® data logger, and will be operated according to manufacturer's instructions. The continuous water level monitoring will be conducted to determine if the well is influenced by pumping at the nearby supply wells and to determine rough aquifer properties.

Field Procedures for these Activities are detailed in:

- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-8 Environmental Data Management
- TSOP 4-9 Aquifer Performance Tests, Section 5.2 – Continuous Background Monitoring
- Worksheet 17h Decontamination Procedures

QAPP Worksheet # 17e
Sampling Design and Rationale
Synoptic Water Level/Port Pressure Measurements

One round of synoptic water level elevation measurements (in existing wells 10019 and 10020) and port pressure measurements (in 11 multi-port wells) will be collected prior to groundwater sampling. Water level measurements will be collected from the single-screen monitoring wells (10019 and 10020) using an electronic water level indicator, at the surveyors mark on the inner casing. Port pressure measurements will be conducted using the MOSDAX® pressure probe that is part of the Westbay sampling assembly. Measurements will be conducted in accordance with the MOSDAX® Sampler Probe Operations Manual (included as Appendix E).

The water level and port pressure data will be used to update the potentiometric surface maps created for the RI Report and to provide current groundwater elevation data for the RD. Before collecting groundwater elevation measurements, each new well location and elevation will be determined by a licensed land surveyor. Elevation measurements will be made at marked points on the inner casing, the top of outer protective casing, and the adjacent ground surface. The wells will be allowed to equilibrate after development for a minimum of two weeks before water level measurements are taken.

Field Procedures for these Activities are detailed in:

- TSOP 1-6 — Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators (and manufacturer's instructions)
- TSOP 1-10 — Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 4-1 — Field Logbook Content and Control, with a RAC II clarification
- Appendix E — MOSDAX Sampler Probe Operations Manual
- Worksheet 17h — Decontamination Procedures

QAPP Worksheet # 17f
Sampling Design and Rationale
Groundwater Sampling

One round of groundwater samples will be collected from 11 multi-port wells (95 ports), 2 supply wells, and 2 existing wells (10019 and 10020). Multi-port wells will be sampled with Westbay MOSDAX sampling equipment designed to be used with their system (Appendix E). The 2 existing wells will be purged with a Grundfos Rediflow 2 submersible pump and sampled according to the site-specific low-flow, minimal drawdown sampling procedure, which follows the EPA SOP "Ground Water Sampling Procedure, Low Stress (Low Flow) Purging and Sampling (EPA 1998). The two supply wells will be sampled from a tap prior to any treatment, in accordance with TSOP 1-9, Tap Water Sampling.

Sample analyses are summarized below.

- All samples: TCL trace VOCs.
- Multi-port wells SVP-2, SVP-4, SVP-5, SVP-9, SVP-10 (3 samples per well - 15 samples total): total iron, dissolved iron, total manganese, dissolved manganese, pH, hardness, and TSS.
- SVP-4 and the three new multi-port wells: TAL from one port per well

Dissolved oxygen, oxidation reduction potential (as Eh), turbidity, pH, temperature, and specific conductivity will be measured in the field. A flow-through cell will be used when measuring oxygen-sensitive field parameters.

Field Procedures for these activities are detailed in:

- Appendix A — Site-Specific Low Flow Groundwater Purging and Sampling Procedure
- Appendix E — MOSDAX Sampler Probe Operations Manual
- TSOP 1-2 — Sample Custody
- TSOP 1-6 — Water Level Measurement, Section 5.2.3 Water Level Measurement Using Electronic Water Level Indicators (and manufacturers instructions)
- TSOP 1-9 — Tap Water Sampling
- TSOP 1-10 — Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 2-1 — Packaging and Shipping Environmental Samples
- TSOP 2-2 — Guide to Handling Investigation Derived Waste
- TSOP 4-1 — Field Logbook Content and Control, with a RAC II clarification
- Worksheet 17h — Decontamination Procedures
- Worksheet 18 — Sampling Locations and Methods/ SOP Requirements

QAPP Worksheet # 17g
Sampling Design and Rationale
Geotechnical Investigation

Geotechnical field investigation activities will be performed to obtain information necessary to design the treatment facility building foundation and verify the infiltration capacity of Nassau county recharge basin #124. The following activities will be performed:

- Two geotechnical borings for the building foundation design (35 feet deep, continuous split spoons from 0-10 feet, then split spoons every 5 feet)
- Four borings in Nassau County recharge basin #124 (35 feet deep, split spoons every 5 feet)
- Four infiltration tests (sealed double ring infiltrameter [SDRI] testing)

All geotechnical investigation activities will be performed by the drilling subcontractor or the drilling subcontractor's lower tier geotechnical subcontractor, including all sample collection, geotechnical sample analyses, infiltration testing, and preparation of a geotechnical report.

All sample analyses will be performed in accordance with American Society for Testing and Materials (ASTM) standards.

Treatment Facility Building Foundation Borings/Soil Sampling
Geotechnical testing will be conducted to obtain information about the bearing capacity and settling characteristics of the soil, which are necessary for the building foundation design. This information will be provided to the prospective bidders for the treatment facility to better estimate the cost of the building foundation. Additional borings may be required during construction to comply with local building requirements.

Two borings are proposed; the approximate boring locations are shown on Figure 4. The borings will be conducted using hollow stem augers, and each boring will be completed to a depth of approximately 35 feet bgs. Split spoon samples will be collected continuously from the ground surface to 10 feet bgs and at 15, 20, 25, 30 and 35 feet bgs, with standard penetration testing (ASTM D1586) performed on each sample. The lithology of each sample will be characterized and logged by the drilling subcontractor's geotechnical representative. Soil samples for geotechnical laboratory analyses will be collected at intervals 2 to 4 feet, 6 to 8 feet, 10 to 12 feet and 14 to 16 feet bgs and sent to the geotechnical laboratory for particle size (sieve and hydrometer, ASTM D421/D422) and natural moisture content (ASTM D2216) analyses. If clayey layers are encountered, soil samples will be collected in accordance with ASTM D4318 and sent to the geotechnical laboratory for testing for Atterberg limits.

Groundwater Recharge Basin Borings/Soil Sampling
Treated effluent from the groundwater treatment facility will be discharged to Nassau County recharge basin #124. Four soil borings will be conducted in the recharge basin to ensure the basin has adequate infiltration capacity for the effluent. Each boring will be approximately 35 feet deep. Soil samples for geotechnical laboratory analyses will be collected every five feet (7 samples per boring) and sent to the geotechnical laboratory for analysis for particle size (sieve and hydrometer, ASTM D422 and D421).

Groundwater Recharge Basin Infiltration Tests
Four SDRI percolation tests will be performed in the recharge basin in accordance with ASTM D3385 to obtain infiltration rates for the basin. The test locations will be selected to be representative of all areas of the basin.

QAPP Worksheet # 17g
Sampling Design and Rationale
Geotechnical Investigation

Geotechnical Report
The drilling subcontractor or the drilling subcontractor's lower tier geotechnical subcontractor will prepare and submit a geotechnical report to CDM that summarizes the results of the geotechnical investigation activities. The report will include infiltration rates, the International Building Code (IBC) classification, bearing capacity estimates, and recommendations regarding the design of the recharge basin and treatment facility building foundation. The report will be stamped by a licensed geotechnical professional engineer (PE) employed by the drilling subcontractor or the drilling subcontractor's lower tier geotechnical subcontractor.

Field Procedures for these Activities are detailed in:
ASTM methods: D421/422, D1586, D2216, D3385, and D4318
TSOP 3-5: Lithologic Logging

QAPP Worksheet # 17h
Sampling Design and Rationale
Decontamination Procedures

Field decontamination will be performed on all personnel and equipment that enters the exclusion zone. Personnel decontamination procedures will be implemented to prevent worker exposure to site contaminants. Equipment decontamination procedures will be implemented to prevent cross-contamination of environmental samples and prevent off-site migration of contaminants as a result of site investigation activities.

Personal Protective Equipment

- Non-residual detergent (Alconox) and tap water rinse
- Respirator sanitizer (for respirator or self contained breathing apparatus face piece)
- Thorough rinse with potable water
- Air dry

Field Monitoring and Geophysical Logging Equipment

Instruments should be cleaned per manufacturer's instructions. The electronic water level indicators, multi-port well sampling equipment, geophysical logging equipment, and water quality parameter probes cannot be rinsed with solvents or acids. The electronic water level indicators will be decontaminated with a non-phosphate detergent, tap water rinse, and a final distilled/deionized water rinse prior to use at each well. The water quality parameter probes will be rinsed prior to and after each use with deionized/distilled water only.

Well Components

Well components must be steam cleaned prior to installation to ensure that all oils, greases, and waxes have been removed. The components should be stored using clean polyethylene sheeting to keep the possibility of contamination to a minimum.

Drilling Equipment and Other Large Pieces of Equipment

All drilling equipment that comes in contact with the soil or groundwater must be steam cleaned before use, and after drilling each borehole. This includes drill rods, bits and augers, dredges, or any other large piece of equipment. Sampling devices such as split-spoons must be decontaminated after each use, by the procedure listed below.

Sampling Apparatus, General Considerations

All sampling apparatus must be properly decontaminated prior to its use in the field to prevent cross-contamination. Equipment should be decontaminated after usage (once a day or on an as needed basis). Decontamination will be performed in an area outside the contamination zone. Enough equipment will be available to be dedicated to the sampling points planned each day.

QAPP Worksheet # 17h
Sampling Design and Rationale
Decontamination Procedures

Decontamination Procedure:
The required decontamination procedure for all sampling equipment (except multi-port well sampling equipment which can only be rinsed with analyte free water) is:

- * a. wash and scrub with low phosphate detergent
- ** b. tap water rinse
- c. 10 percent nitric acid rinse (for metals analysis only), laboratory grade (one percent solution will be used when carbon steel equipments, such as split-spoons, are used)
- d. demonstrated analyte-free water rinse
- *** e. isopropanol rinse (all solvents must be pesticide-grade or better)
- **** f. demonstrated analyte-free water rinse (amount of water must be at least five times that of the solvents used)
- g. air dry
- h. wrap in aluminum foil, shiny side out, for transport

* Tap water must be from a municipal water treatment system. The use of an untreated potable water supply is not an acceptable substitute.
** Nitric acid rinse will only be used when samples are collected for metals
*** Solvent rinse required only when sampling for organics.
**** A sample of the demonstrated analyte-free water will be collected and submitted for chemical analysis. Analytical results will be kept on-site. Determination of analyte-free water will be according to the EPA Region II CERCLA QA Manual (EPA 1989) (see page 59).

While performing decontamination activities, phthalate-free gloves should be used to prevent phthalate contamination of the sampling equipment that could result from the interaction of the gloves with the organic solvents.

Decontamination Equipment
- Steam cleaner
- Distilled/deionized water
- Potable water
- Deep basins
- Brush
- Acetone or isopropynol (pesticide-grade)
- Personnel protective equipment
- 10 percent nitric acid (one percent when needed), ultra pure grade
- Power source (e.g., generator), if required
- Demonstrated analyte-free water
- Polyethylene sheeting
- Utility knife
- Non-phosphate detergent (i.e. Alconox)
- Aluminum foil
- Air monitoring equipment and calibration gas

Field Procedures for these Activities are detailed in:
- TSOP 4-5 Field Equipment Decontamination at Nonradioactive Sites.

QAPP Worksheet #18
Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ID Number[1]	Matrix	Depth	Analytical Group	Concentration Level	Number of Samples (identify field duplicates)[3]	Sampling SOP Reference	Rationale for Sampling Location[4]
Monitoring Well Sampling – 1 Round	Groundwater[2]		TCL VOCs, TAL metals[5], total and dissolved iron, total and dissolved manganese, pH, hardness, TSS	Trace/ Low	VOCs: 99 TAL metals: 4 All others: 15	Appendix A Appendix E TSOP 1-9	Table 1
Building Foundation Geotechnical Sampling – 2 locations	Soil	2-4 feet, 6-8 feet, 10-12 feet, and 14-16 feet bgs	Grain size, moisture content, and Atterberg limits (only if clayey layers are encountered)	Various	8 grain size and moisture content – 4 per boring; 2 Atterberg limits - 1 per location if clayey soils are encountered	ASTM D421/422, D1586, D2216	See Worksheet #17g
Recharge Basin Geotechnical Sampling – 4 locations	Soil	5-7 feet, 10-12 feet, 15-17 feet, 20-22 feet, 25-27 feet, 30-32 feet, 35-37 feet	Grain size	N/A	28 (7 per boring, every 5 feet)	ASTM D421/422	See Worksheet #17g

1. See Worksheet #17 for a description of the sampling activities
2. Groundwater samples will also be measured for field parameters: dissolved oxygen, oxidation-reduction potential, turbidity, pH, temperature, and conductivity.
3. Field duplicates are collected at a rate of one per 20 samples. See worksheet #20 for number of field duplicates.
4. Proposed sample locations are shown in Figure 3 and Figure 4.
5. The wells for which full TAL metals analysis is required are noted on worksheet #11 and the number of samples on worksheet #20.

QAPP Worksheet #19
Analytical SOP Requirements Table

Matrix	Analytical Group	Concen -tration Level	Analytical/ Preparation Method/SOP Reference [1]	Minimum Sample Volume	Containers [2,3] (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/ analysis)
Aqueous	TCL VOCs (trace)	Trace	SOM01.2	80 ml	3 X 40 ml vials with Teflon septum	HCl to pH<2; Cool to 4 degrees C. No head space or air bubbles	10 days preserved-VTSR (14 days technical)
Aqueous	TAL metals, total/dissolved iron, total/dissolved manganese	Low	ILM05.4 (ICP-AES, & ICP-MS)	2 liters (ICP-AES & ICP-MS)	2-1 liter polyethylene bottles	HNO_3 to pH <2; Cool to 4 degrees C	178 days VTSR (180 days technical);
Aqueous	Hardness	Low	130.1/130.2 or ILM05.3/200.7 by calculation	100 ml	1-250 polyethylene bottle	HNO_3 to pH<2; Cool to 4 degrees C	6 months
Aqueous	TSS	Low	160.2	100 ml	1-250 ml polyethylene bottle	Cool to 4 degrees C	7 days
Soil [4]	Moisture	Low	SOM01.2	40 ml	1-40 ml glass jar/PTFE lined septa/open top screw caps (no headspace)	Cool to 4 degrees C	48 hours
Soil [4]	Grain Size	Low	ASTM D421-85 ASTM D422-63	500 g	1-8 oz jar	Cool to 4 degrees C	None
Soil [4]	Atterberg Limits	N/A	ASTM D1586 ASTM D2216 ASTM D4318	N/A[5]	N/A[5]	N/A[5]	N/A[5]

QAPP Worksheet #19
Analytical SOP Requirements Table

Notes:

ASTM	American Society for Testing Materials	ml	milliliter
C	Celsius	g	gram
HCl	Hydrochloric Acid	VOC	Volatile organic compound
HNO3	Nitric Acid	VTSR	Verified Days to Sample Receipt
ASTM	American Society of Testing and Materials	N/A	not applicable

1. SOP reference numbers are laboratory specific. This information is maintained by EPA and is not available to EPA contractors.
2. Aqueous VOC vials must be filled to capacity with no headspace or air bubbles.
3. No MS/MSD analyses are required for VOC analysis.
4. Geotechnical specialists will collect the soils and conduct the ASTM tests through the site driller or as a lower tier subcontractor to the driller.

QAPP Worksheet #20
Field Quality Control Sample Summary Table

Field Task	Matrix	Analytical Parameters	Environmental Samples	Field Duplicates	MS/MD[1,4]	Field Blanks[2]	Trip Blanks[3]
Monitoring Well Sampling (1 Round)	GW	TCL VOCs (trace)	99	5	N/A	7	7
		TAL metals	4	1	1	1	N/A
		total iron, dissolved iron, total manganese, dissolved manganese	15	1	1	3	N/A
		hardness, pH, and TSS	15	1	1	0	N/A
Building Foundation Geotechnical Sampling[5]	SOIL	Grain size, moisture content	8	1	0	0	0
		Atterberg limits (only if clayey soils are encountered)	2	1	0	0	0
Recharge Basin Geotechnical Sampling[5]	SOIL	Grain size	28	2	0	0	0

Notes:
1 : Matrix Spike (MS)/Matrix Duplicate (MD) for TAL metals and laboratory duplicate (D) for hardness, pH, and TSS. lab QC for every 20 samples.
2: Field blanks are collected at a frequency of 1 per day per decontamination event. The actual number of field blanks may be different due to the number of decontamination events and days for sampling.
3: Trip blanks (for VOCs only) are collected at a frequency of 1 per day per cooler of VOCs
4: If using SOM01.2, MS/MSDs are not needed for VOCs
5: Geotechnical samples will be analyzed by the drilling subcontractor's geotechnical lab or a lower tier geotechnical subcontract laboratory.

TCL = Target Compound List
VOCs = Volatile Organic Compound
TAL = Target Analyte List
GW = Groundwater
TSS = Total suspended solids
N/A = Not applicable

QAPP Worksheet #21
Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
1-2	Sample Custody, Rev. 5, 3/31/07	CDM	NA	Y	RAC II-Specific clarification applies
1-4	Subsurface Sampling, Rev. 6, 3/31/07	CDM	Section 4 of TSOP Mud-Rotary Drill	Y	RAC II-Specific clarification applies
1-6	Water Level Measurement, Rev. 6, 3/31/07	CDM	Section 4 of TSOP	N	
1-9	Tap Water Sampling, Rev. 4, March 2007	CDM	Section 4 of TSOP	N	
1-10	Field Measurement of Organic Vapors, Rev. 4, 3/31/07	CDM	Section 4 of TSOP Mini-RAE	N	
2-1	Packaging and Shipping Environmental Samples, Rev. 3, 3/31/07	CDM	Section 1.3 of TSOP	Y	RAC II-Specific clarification applies
2-2	Guide to Handling of Investigation-Derived Waste, Rev. 5, 3/31/07	CDM	NA	N	
3-2	Topographic Survey, Rev. 6, 3/31/07	CDM	NA	N	
3-4	Geophysical Logging, Calibration, and Quality Control	CDM	Section 5.2 of TSOP Century 9012 gamma log or equivalent	N	
3-5	Lithologic Logging	CDM			
4-1	Field Logbook Content and Control, Rev. 6, 3/31/07	CDM	NA	Y	RAC II-Specific clarification applies
4-2	Photographic Documentation of Field Activities, Rev. 7, 3/31/07	CDM	Camera	N	
4-3	Well Development and Purging, Rev. 5, 3/31/07	CDM	Section 4 of TSOP YSI	Y	RAC II-Specific clarification applies
4-4	Design and Installation of Monitoring Wells in Aquifers, Rev. 6, 3/31/07	CDM	See Worksheet 17c Mud-Rotary Drill	Y	RAC II-Specific clarification applies
4-5	Field Equipment Decontamination at Nonradioactive Sites, Rev. 7, 3/31/07	CDM	Section 4 of TSOP	Y	RAC II-Specific clarification applies
4-8	Environmental Data Management, Rev. 1, 3/31/07	CDM	NA	Y	Modified by Appendix D

QAPP Worksheet #21
Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
4-9	Aquifer Performance Tests/Continuous Water Level Measurements	CDM	Section 5.2 of TSOP	N	
5-1	Control of Measurement and Test Equipment, Rev. 8, 3/31/07	CDM	NA	Y	RAC II-Specific clarification applies
Appendix E	MOSDAX Sampler Probe Operations Manual	Schlumberger	Westbay	N	
Appendix A	Site-Specific Low Flow Groundwater Purging And Sampling Procedure	CDM	Section IV of Procedure in Appendix A	N	
D1586	Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils	ASTM	Section 5 of Procedure in Appendix A	N	

Note: Amendments to RAC II Clarifications are noted within QAPP worksheets.

QAPP Worksheet #22
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Mini RAE Dual PID Toxic Gas Monitor with 11.7 eV lamp	Calibration checked at the beginning and end of day	As needed in field; semi-annually by supplier	Measure known concentration of Isobutylene 100 ppm (calibration gas)	Upon receipt, Successful operation	Calibrate am, check pm	± 10% of the calibrated value	Manually zero meter or service as necessary and recalibrate	Field Team Leader) (FTL)	Manufacturers specifications
YSI 600XL Water Quality Checker	Calibrate at the beginning of the day and check calibration at the end of the day	Performed before shipment and as needed	Measure solutions with known values (National Institute for Standards and Technology (NIST) traceable buffers and conductivity calibration solutions)	Upon receipt, Successful operation	Daily, before each use	pH: ± 0.05 Specific Conductivity: ±5micro Siemens (µS) DO ± 0.02 ppm Temp.: ±0.3°C	Recalibrate or service as necessary	FTL	Manufacturers specifications
La Mott Turbidity Meter Model 2020	Calibrate daily before each use	As needed	Measure solutions with known turbidity standards	Upon receipt, Successful operation	Daily prior to use	N/A (instrument zeroed)	Manually zero or service as necessary and recalibrate	FTL	Manufacturers specifications
Water Level Meter	N/A	None	Check daily, before each use	Check instruments are in working order	Check daily before each use	Pass/Fail	Return to rental company for replacement	FTL	Manufacturers specifications
MOSDAX Sampler Probe	None	Check after each well	Check probe is in working order	Check probe is in working order	Check after each well	Pass/Fail	Contact Westbay	FTL	Manufacturers specifications

QAPP Worksheet #23
Analytical SOP References Table

Reference Number(1)	Title, Revision, Date, and/or No.	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Project Work Modified (Y/N)
CLP Organic and Inorganic Methods						
SOM01.2	Multi-Media, Multi-Concentration, Organic Analytical Service for Superfund. EPA 2005, amended 4.11.2007	Definitive	TCL VOC (trace)	Gas Chromatograph/Mass Spectrometer (GC/MS)	DESA or CLP	N
ILM05.4 (AES & MS) TAL metals	Multi-Media, Multi-Concentration, Inorganic Analytical Service for Superfund EPA 2007	Definitive	TAL Metals	ICP-Atomic Emission Spectrometer (AES) and ICP-MS	DESA or CLP	N
Wet Chemistry Methods						
130.1, 130.2	Method for Chemical Analysis of Water and Wastes (MCAWW). Revised 1983	Definitive	Hardness	Colorimeter, automated or titrimetric	DESA	N
200.7	MCAWW. Revised 1983	Definitive	Hardness	ICP-Atomic Emission Spectrometer (AES)	DESA	N
160.2	MCAWW. Revised 1983	Definitive	TSS	Balance, oven	DESA	N
Soil and Field Analytical Methods						
ASTM D421-85	Standard Practice for Dry Preparation of Soil Samples. 2002	Definitive	Grain size	Sieves, hydrometer	Geotechnical specialist laboratory	N
ASTM D422-63	Standard Test Method for Particle-Size Analysis of Soils. 2002	Definitive	Grain size	Sieves, hydrometer	Geotechnical specialist laboratory	N
TSOP 1-10 and Manufacturer's Manual	Field Measurement of Organic Vapors / Manufacturer's Manual	Screening	VOC	MiniRAE PID (Photoionization Detector) -Toxic Gas Monitor	CDM field personnel	N

QAPP Worksheet #23
Analytical SOP References Table

Reference Number(1)	Title, Revision, Date, and/or No.	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Project Work Modified (Y/N)
Not Available	Manufacturer's Manual	Definitive	Turbidity	LaMotte Turbidity Meter, Model 2020	CDM field personnel	N
Not Available	Manufacturer's Manual	Definitive	pH-aqueous	YSI Water Quality Checker, Model 600 XL	CDM field personnel	N
			Oxidation-reduction Potential			N
			Dissolved Oxygen			N
			Specific Conductance			N
			Temperature			N
ASTM D1586-99	Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils, 1999	Definitive	Atterberg Limits	Drilling Equipment Spilt Barrel	Geotechnical Specialist Laboratory	N
ASTM D2216-05	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass	Definitive	Moisture for Atterberg Limits	Oven and Balance	Geotechnical Specialty Laboratory	N
ASTM D4318-05	Liquid Limit, Plastic Limit and Plasticity Index of Soils	Definitive	Atterberg Limits	Liquid Limit Device	Geotechnical Specialist Laboratory	N

QAPP Worksheet # 23
Analytical SOP References Table

1. CLP laboratories SOPs are reviewed through EPA. DESA laboratory specific SOPs will apply and not these generic SOPs whenever the DESA laboratory is able to perform the analyses. The Region II Field and Analytical Services Teaming Advisory Committee (FASTAC) Policy will be implemented for procuring laboratory services. Because of the limited sampling, it is assumed DESA will analyze the samples indicated.
2. For non-RAS data, the ASC will submit the electronic "Analytical Services Tracking System (ANSETS) Data Requirement" form to the Regional Sample Control Coordinator (RSCC) by the first day of each month for the previous month's sampling.

QAPP Worksheet #24
Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA[1]	SOP Reference[2]
Instruments used for EPA CLP analyses follow the calibration frequencies outlined in each method SOP.						
GC/MS	Initial Calibration; 5 point standards	After instrument set up or when daily 12-hour calibration check fails	All target compounds, initial relative standard deviation (RSD) ≤ 10% or 20% and $R^3 > 0.995$	Inspect system; correct problem; re-run failed calibration and any associated samples	Lab analyst / QA officer - (TBD)	TBD
	Continuing Calibration Verification (CCV)	Daily; every 12-hours of analysis	%D ≤15%			
	Calibration Standards Verification	Each lot of standards	As per lab established control limits	Inspect system; correct problem; re-run standard and affected samples		
GC/MS	Tuning	Daily; every 12-hours of analysis	Response factors and relative response factors as method specified	Inspect system; correct problem; re-run standard and affected samples	Lab analyst / QA officer - TBD	TBD
ICP-AES and ICP-MS	Calibration; 2 point standards (blank and standard)	Daily	90-110 % recovery	Re-calibrate instrument	Lab analyst / QA officer - TBD	TBD
ICP-AES and ICP-MS	ICV	Before sample analysis	90-110% recovery; source of standard separate from calibration standards	Re-calibrate instrument; prepare fresh ICV standards; do not analyze samples until problem is corrected	Lab analyst / QA officer - TBD	TBD

QAPP Worksheet #24
Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA[1]	SOP Reference[2]
ICP-AES and ICP MS	Reporting Limit Standard	After initial calibration verification standard	80-120% recovery or concentration ≤ 30% difference (from true value)	Re-analyze failed standard	Lab analyst / QA officer - TBD	TBD
ICP-AES and ICP-MS	CCV	Every 10 samples and at end of analytical sequence	90-110% recovery; source of standard separate from calibration standards	Re-check; re-calibrate and rerun all samples analyzed after last valid CCV	Lab analyst / QA officer - TBD	TBD
ICP-MS	Tuning	Daily; prior to calibration and sample analysis	Response factors and relative response factors as method specified	Inspect system; correct problem, rerun standard and affected samples	Lab analyst / QA officer - TBD	TBD
Colorimeter	Initial Calibration; 4 - 9 point standards	Every 3 months; every 6 months for method 300. or as per lab SOP	90-110 % recovery	Re-check; re-calibrate	Lab analyst / QA officer - TBD	TBD
	Calibration check	Every 10 samples and at end of analytical run	80-120 % recovery	Re-check re-calibrate and rerun all samples analyzed after last valid calibration check	Lab analyst / QA officer - TBD	TBD
pH meter	Daily buffer checks (2 point bracketing sample pH)	Before use/per batch; other checks as per rental company and manufacturer's recommendations	± 0.1 pH units or ± 0.05 pH units	Recheck; replace buffer solutions and recheck. If still fails perform instrument check or place out of service	CDM – FTL Lab analyst / QA officer - TBD	TBD
Thermometer	Calibration	Quarterly; serviced annually	See instrument manual	Replace defective thermometer	Lab analyst / QA officer - TBD	TBD

QAPP Worksheet #24
Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA[1]	SOP Reference[2]
Balance	Calibration verification	Daily - before use	See instrument manual	Troubleshoot as per equipment manual/call for repair	Lab analyst / QA officer - TBD	TBD
	Mass check	Daily - before use	See instrument manual			
	Temperature check	Annually	± 2°C		Lab analyst / QA officer - TBD	
Oven	Serviced annually as per Manufacturer's instruction				Lab analyst / QA officer - TBD	TBD

1. The FASTAC decision process will be used for procuring laboratory services. CLP and DESA subcontract laboratory's calibration and/or method SOPs will be utilized to meet calibration criteria. Specific instrument information (Manufacturer and model) is not available at this time.
2. To be determined (TBD) - Reference SOP depends on the laboratory assignment. EPA maintains the CLP laboratory SOP information. If a subcontract laboratory is needed, CDM will submit their SOP as a field change request.
3. R represents the correlation coefficient

QAPP Worksheet #25
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Analytical instrument maintenance, testing and inspection information and availability of spare parts are not available since the FASTAC decision process will be utilized for analytical services.								
Use of a CDM BOA subcontract laboratory is not anticipated for this project.								

QAPP Worksheet #26
Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection: CDM will collect all samples under the supervision of the FTL. Sample numbers will be assigned as described below. A coding system will be used to identify each sample collected during the field investigation phase of the project. This coding system will provide a tracking record to allow retrieval of information about a particular sample and ensure that each sample is uniquely identified. Each sample is identified by a unique code which indicates the sample type, sample number, and, in some cases, sample depth. A sample numbering system is described below which provides a unique identifier for all samples that will be collected during the site field investigation. The total number and types of samples collected are detailed in Worksheet #18. **Monitoring Well Samples** The groundwater samples will be named using the methodology established in the RI sampling rounds. All pre-design samples names will include "R3" to designate the third round of monitoring well sampling (the first two rounds were collected during the RI/FS). For example a groundwater sample collected from multi-port well SVP-4 will be labeled GWM-04-1-R3, with the "1" indicating port 1 (deepest port). Single screen monitoring well samples will be named as follows: GWX-10019-R3. The supply wells will be named as follows: GWP-10-R3. A total of 99 samples will be collected during Round 3.
Geotechnical Samples The building foundation and recharge basin samples will be collected by the drilling subcontractor's geotechnical specialist or by a low tier geotechnical subcontractor. CDM will provide them with the following sample naming scheme. The building foundation samples collected will be designated as follows: BB-1, followed by the depth of the sample. A total of two locations (BB-1 and BB-2) will be sampled. For example a sample collected at 6-8 feet bgs from building boring number one would be labeled BB-1-6-8. The recharge basin samples collected will be designated as follows: RB-1 through RB-4, followed by the sample depth. For example, a sample collected at 15-17 feet from recharge basin boring RB-3 would be labeled RB-3-15-17.
Sample Packaging (Personnel/Organization): Mike Ehnot, CDM will assign sample management task to experienced field personnel. Sample packaging will follow TSOP 1-2 and TSOP 2-1; their RAC II clarifications; and the CLP guidance for Field Samplers, January 2007, with the exception that sample tags and vermiculite will not be used. Forms II Lite is mandatory and will be assigned to experienced field personnel.
Coordination of Shipment (Personnel/Organization): Mike Ehnot, CDM
Type of Shipment/Carrier: Federal Express Priority Overnight Shipping. Samples for Saturday delivery will have the FedEx airbills checked for Saturday delivery.
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Laboratory Sample Custodian - TBD as per FASTAC. The CLP Laboratory assignment sheet will indicate the laboratory sample custodian, and if a subcontract laboratory is required. The laboratory project officer will notify CDM of the sample custodian.
Sample Custody and Storage (Personnel/Organization): CDM and TBD as per FASTAC

QAPP Worksheet #26
Sample Handling System

Sample Preparation (Personnel/Organization): TBD as per FASTAC
Sample Determinative Analysis (Personnel/Organization): TBD as per FASTAC
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): All samples will be shipped to a CLP laboratory or DESA on the day of collection via priority overnight (FedEx). Samples may be hand delivered/courier depending on laboratory location. On-site tests will be performed the same day.
Sample Extract/ Digestate Storage (No. of days from extraction/digestion): Refer to Worksheet #19 for holding time requirements
Biological Sample Storage (No. of days from sample collection): Not Applicable
SAMPLE DISPOSAL
Personnel/Organization: Laboratory responsible for analysis will dispose of samples
Number of Days from Analysis: 90 days

QAPP Worksheet #27
Sample Custody Requirements

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):
Packaging will be performed according to the EPA Contract Laboratory Program (CLP) Guidance for Field Samplers, Final (EPA 2007) and TSOP 2-1. To maintain a record of sample collection transfer between field personnel, shipment, and receipt by the laboratory, the applicable sample chain-of-custody paperwork (TSOP 1-2) is completed for each shipment (i.e., cooler) of packed sample bottles. The team member actually performing the sampling is personally responsible for the care and custody of the samples collected until they are transferred properly. The FTL will review all field sampling activities to confirm that proper custody procedures were followed during the field work. CDM personel relinquishing the sample to the courier will sign the chain of custody record.

All courier receipts and/or paperwork associated with the shipment of samples will serve as a custody record for the samples while they are in transit from the field to the laboratory. Custody seals should remain intact during this transfer.

Coolers are secured with nylon fiber tape and at least two custody seals are placed across cooler openings. Since custody forms are sealed inside the sample cooler and custody seals remain intact, commercial carriers are not required to sign the chain-of-custody form. Examples of custody seals are included in TSOP 1-2.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):
When the samples are delivered to the laboratory, signatures of the laboratory personnel receiving them will be completed in the appropriate spaces on the chain-of-custody record. This will complete sample transfer.

It will be each laboratory's responsibility to maintain internal logbooks and records that provide a custody record throughout sample preparation and analysis. To track field samples through data handling, CDM will maintain photocopies of all chain-of-custody forms.

Sample Identification Procedures:
Refer to Worksheet #26.

Chain-of-custody Procedures:
CDM will follow TSOP 1-2, Sample Custody, for chain-of-custody procedures.

QAPP Worksheet #28
QC Samples Table

QAPP Worksheet #28a
QC Samples Table

Matrix: Aqueous (groundwater)

Analytical Group/Concentration Level: TCL VOC (Trace)

Sampling SOP: Roosevelt Low-flow Groundwater SOP (Appendix A), Tap Sampling TSOP 1-9, or MOSDAX Sampler Probe Users Manual (Appendix E)

Analytical Method / SOP Reference: SOM01.2

Sampler's Name/ Field Sampling Organization: TBD/CDM

Analytical Organization: DESA or EPA CLP (FASTAC will be followed)

No. of Sample Locations: Multi-port monitoring wells: 95 samples. Single screen monitoring wells: 2 samples. Supply wells: 2 samples (total 99 samples)

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ CRQL
Trip blank	1 per cooler containing VOC	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ CRQL
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	1 per 12 hours per instrument	≤ CRQL	Per SOM01.2	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor to inform SM if RPD OR ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
DMC	Each Sample and Standard	28-155	Per SOM01.2	Laboratory analyst	Accuracy	As per method

The number of QC samples is listed on Worksheet 20
ABS applied when sample or duplicate results are detected below contract required quantitation limit (CRQL) or up to 5 times the CRQL.
* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment
LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute value RPD = relative percent difference
DCM = deuterated monitoring compounds

QAPP Worksheet #28b
QC Samples Table

Matrix: Aqueous (groundwater)						
Analytical Group/Concentration Level: TAL Metals; total/dissolved iron, total/dissolved manganese, low						
Sampling SOP: Low-flow Groundwater SOP (Appendix A), Tap Sampling TSOP 1-9, or MOSDAX Sampler Probe Users Manual (Appendix E)						
Analytical Method / SOP Reference: ILM05.4						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA or EPA CLP (FASTAC will be followed)						
No. of Sample Locations: TAL: SVP-4, SVP-9, SVP-10, and SVP-11: one sample from one port from each well (4 samples total); iron/manganese: SVP-2, SVP-4, SVP-5, SVP-9, SVP-10 – 3 samples each						
QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ CRQL
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	Per ILM05.4	≤ CRQL	Per ILM05.4	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples	None	Data assessor inform SM if RPD or ABS exceeds MPC*	Laboratory analyst/FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5x CRQL
Matrix Spike	1 per 20 samples	75-125%	Per ILM05.4	Laboratory analyst/FTL	Accuracy	Recovery 75-125%
Laboratory Duplicate	1 per 20 samples	RPD < 20%	Per ILM05.4	Laboratory analyst/FTL	Precision	RPD ≤ 20%
LCS	1 per 20 samples	80-120% mercury 85-115%	Per ILM05.4	Laboratory analyst/FTL	Accuracy and Precision	80-120%

The number of QC samples are listed on Worksheet 20
ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.
* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment
LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28c
QC Samples Table

Matrix: Aqueous (groundwater)

Analytical Group/Concentration Level: TSS, Hardness/ Low

Sampling SOP: Low-flow Groundwater SOP (Appendix A), Tap Sampling TSOP 1-9, or MOSDAX Sampler Probe Users Manual (Appendix E)

Analytical Method / SOP Reference: TSS by EPA 160.2, Hardness by 130.1/130.2 or ILM05.4 and 200.7

Sampler's Name/ Field Sampling Organization: TBD/CDM

Analytical Organization: DESA or CDM Subcontract lab (FASTAC will be followed)

No. of Sample Locations: SVP-2, SVP-4, SVP-5, SVP-9, SVP-10 – 3 samples each

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ Criteria on Worksheet 15
Calibration blank	1 per sample run	≤ CRQL	Verify results; reanalyze; recalibrate if still outlying	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ Criteria on Worksheet 15
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor to inform SM if RPD OR ABS exceeds MPC	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Detection Limit Verification Standard	1 per sample run	± 20% of true value		Laboratory analyst	Accuracy/bias	± 20% of true value

The number of QC samples are listed on Worksheet 20
ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.
* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment
LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28d
QC Samples Table

Matrix: Soil
Analytical Group/Concentration Level: Grain Size/ Low
Sampling SOP: TSOPs 1-4
Analytical Method / SOP Reference: ASTM D422
Sampler's Name/ Field Sampling Organization: TBD/CDM
Analytical Organization: Geotechnical Specialty laboratory
No. of Sample Locations: 6 locations: 36 samples

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for DV	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor inform SM if RPD or ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 100%
Laboratory duplicate	1 per 20 samples	As per methods	As per methods	Laboratory analyst	Precision	RPD ≤ 40%

The number of QC samples are listed on Worksheet 20
ABS applied when sample or duplicate results are detected below CQL or up to 5 times the CQL.
* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment
LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #29
Project Documents and Records Table

Sample Collection Documents and Records	On-Site Analysis Documents and Records	Off-Site Analysis Documents and Records	Data Assessment Documents and Records	Other
Forms II Lite Traffic Reports/ COC Records	Equipment Calibration and Maintenance Log	Sample Receipt, Custody and Tracking Logs	Field Sampling Audit Plans, Reports and Checklists	M&TE (measurement and testing equipment) Forms
Airbills	Field Data Collection Logs	Standards Tracking Logs	Office Audit Plans, Reports and Checklist	Technical/QA Review Forms
Sample Tracking Log/Sheets	Drilling Logs	Equipment Maintenance, Testing and Inspection Log	Corrective Action Reports	Purchase Requisition Forms
Field Logbooks	PID Logs	Sample Preparation Logs	Analytical sample results	Telephone Logs
Chain of Custody Forms	Water Quality Data Logs	Corrective Action Reports	Subcontract Laboratory certifications	Electronic Data Deliverables
Field Change Request Forms	Monitoring Well Logs	Run Logs	Subcontract Laboratory QA Plan (on file with EPA and CDM)	Subcontract Documents (Contract, Scopes of Work, Bid Sheet), Subcontract Documents and Review Forms
Custody Seals	Photographs	Corrective Action Forms	Laboratory Audit Report (optional)	NA
Daily/weekly reports	Meteorological Data from field (documented in Field Logbooks)	Data Packages (Case Narratives, Sample Results, QC Summaries and Raw Data (detailed in CLP SOPs).	Data Package Completeness Checklist Validated Data Reports	NA
ANSETS Forms	NA	Trip Reports	Self Assessment Checklist	NA
Survey Records	Gamma Logs Water Level Measurement logs	Sample Disposal and Waste Manifests	Data Quality Assessments	NA

QAPP Worksheet #30
Project Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ ID Number	Analytical SOP[1]	Data Package Turnaround Time [3]	Laboratory / Organization (name, address, contact person & telephone number)	Backup Laboratory / Organization[2] (name, address, contact person & telephone number)
Monitoring Well Groundwater Sampling							
Aqueous	TCL VOCs (trace)	Trace	see Figure 3/ worksheet # 26	SOM01.2	14 days	DESA EPA Primary contact: RSCC Adly Michael/Bob Toth 732-906-6161/6171 DESA contact: John Birri 732-906-6886	EPA CLP – TBD via RSCC
Aqueous	TAL metals (4 samples) Dissolved iron Total iron Dissolved manganese Total manganese (15 samples)	Low	see Figure 3/ worksheet # 26	ILM05.4 (ICP-AES & ICP-MS)	14 days	DESA EPA Primary contact: RSCC Adly Michael/Bob Toth 732-906-6161/6171 DESA contact: John Birri 732-906-6886	EPA CLP- TBD via RSCC
Aqueous	Hardness, TSS	Low		Various (Worksheet 19)	14 days	DESA EPA Primary contact: RSCC Adly Michael/Bob Toth 732-906-6161/6171 DESA contact: John Birri 732-906-6886	

QAPP Worksheet #30
Project Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ ID Number	Analytical SOP[1]	Data Package Turnaround Time [3]	Laboratory / Organization (name, address, contact person & telephone number)	Backup Laboratory / Organization[2] (name, address, contact person & telephone number)
Building Foundation Geotechnical Soil Sampling							
Soil	Grain Size, Atterberg Limits, moisture content	Low	see Figure 4/ worksheet # 26	D421-85 & D422-63, ASTM D1586 D2216 D4318	TBD	TBD	Geotechnical Subcontract laboratory (part of drilling subcontract)
Recharge Basin Geotechnical Sampling							
Soil	Grain Size	Low	worksheet # 26	D421-85 & D422-63	TBD	TBD	Geotechnical Subcontract laboratory (part of drilling subcontract)

1. Please note that the required quantitation limits and CLP method options are detailed on worksheet 15.
2. Use of a CDM BOA subcontractor laboratory is not anticipated for this site.
3. The data package will be expected from EPA CLP and DESA within 14 days.

QAPP Worksheet #31
Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Sample collection and documentation	Once	External	EPA	TBD	Susan Schofield (SM)	Susan Schofield (SM)	Jeniffer Oxford, or field auditor
Health and Safety	Once if warranted	Internal/ External	EPA	TBD	Susan Schofield (SM)	Susan Schofield (SM)	Shawn Oliveira or designee, SSHO
Field Audit	Once	Internal	CDM	Approved field auditor	Susan Schofield (SM)	Project Geologist and field staff	Jeniffer Oxford, Field Auditor
Office Audit	Once	Internal	CDM	Approved CDM QA Staff	Susan Schofield (SM)	Susan Schofield (SM)	Jeniffer Oxford or designee, SM
QAPP	Annually	Internal	CDM	Approved CDM QA Staff or QA Coordinator	Susan Schofield (SM)	Susan Schofield (SM)	Jeniffer Oxford
Data Review	Once	Internal	CDM	Scott Kirchner or designee	Susan Schofield (SM)	Susan Schofield (SM) & Laboratory manager(s) (TBD)	Scott Kirchner, SM
Management Systems Review	Annually	Internal	CDM	Doug Updike	Jeanne Litwin (RAC II PSO)	Jeanne Litwin, Susan Schofield (SM)	Doug Updike

QAPP Worksheet #32
Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Org.)	Timeframe for Response
Sample collection and documentation	Memorandum	Lisa Campbell (PDTM) Susan Schofield (SM)	Day of audit	Verbal briefing; Corrective Action Notice if immediate corrective action not possible or critical violations noted	Jeniffer Oxford, CDM QA Coordinator; Doug Updike, CDM QA Manager	Immediate CA required where possible; otherwise as specified on the CA Notice, typically 15 to 30 days from date of CA Notice
Health and Safety	Audit checklist	Susan Schofield (SM)	Notify by phone immediately Report 1 week after audit	Memorandum and checklist	Shawn Oliveira, CDM Health and Safety Manager	
Field Audit	Field Audit Report	Lisa Campbell (PDTM) Susan Schofield (SM)	Provide summary of findings to field team on day of audit; Draft Report due within 10-15 days	Corrective Action Plan	Jeniffer Oxford, CDM RQAC Coordinator; Doug Updike, CDM QA Manager	
Office Audit	Office Audit Report	Susan Schofield (SM)	Provide summary of findings to SM on day of audit; Draft Report due within 10-15 days	Memorandum	Jeniffer Oxford, CDM RQAC, Doug Updike, CDM QA Manager	
QAPP	Memorandum	Susan Schofield (SM)	Draft Report due 30 days	Memorandum and/or FCRs	Jeniffer Oxford, CDM RQAC,	
Data Review	Memorandum	Scott Kirchner (ASC)	Notify by phone immediately	Memorandum	Susan Schofield (SM)	
Management Systems Review	MSR report	Jeanne Litwin (RAC II PSO)	2 weeks After Review	Memorandum	Doug Updike, CDM QA Manager	

QAPP Worksheet #33
QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Field Change Requests	As needed	3/17/2008 – 5/23/2008	Joseph Button (FTL)	QAPP recipients
QAPP Addendums	As needed	3/17/2008 – 5/23/2008	Lisa Campbell (PDTM)	QAPP recipients
Field Audit Report	Once	3/17/2008 – 5/23/2008	Field Auditor	Susan Schofield, SM Jeanne Litwin, Program Manager, Doug Updike, QA Manager, Caroline Kwan, EPA RPM William Sy, EPA QA
Office Audit Report	Once	11/28/2008 - 12/5/2008	Jeniffer Oxford, (RQAC) or designee	
Corrective Action Reports	As required on CA request	12/5/2008	QA Auditor	
Data Usability Assessments	With each Measurement Report	7/3/2008 – 7/23/2008	Scott Kirchner (ASC)	Fernando Rosado, EPA Caroline Kwan, EPA RPM Other EPA and stakeholders as directed by the EPA RPM Susan Schofield, SM Jeanne Litwin, Program Manager
RD Report (Draft and Final)	Once	6/30/2008 – 11/28/2008	SM	
Geotechnical Report	Once	4/21/2008–6/10/2008	Geotechnical Subcontractor	CDM

QAPP Worksheet #34
Verification (Step I) Process Table

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Chain of custody	Form will be internally reviewed upon completion and verified against field logs, laboratory report and QAPP. Review will be conducted with completion of each measurement report.	Both	ESAT or EPA validator Lisa Campbell (PDTM) - CDM Scott Kirchner (ASC) - CDM
Field Report	Field reports will be verified with field log books to ensure correct reporting of information. Review will be conducted with completion of each report.	Internal	Lisa Campbell (PDTM) - CDM
Field Logbooks	Field logbooks will be reviewed for accuracy and completeness and placed in project file.	Internal	Lisa Campbell (PDTM) - CDM
Laboratory Logbooks	Laboratory logbooks will be reviewed for accuracy and completeness and placed in project file.	External	CLP or DESA
Field and Laboratory data and QC Report	Data validation reports, QAPP, FCRs and outputs of the EQuiS database will be used to prepare the project data quality and usability assessment report. The data will be evaluated against project DQOs and measurement performance criteria, such as completeness.	Both	Scott Kirchner (ASC) - CDM
Field Sampling Procedures	Evaluate whether field sampling procedures were followed with respect to equipment and proper sampling support using audit and sampling reports, field change request forms and field logbooks.	Internal	Lisa Campbell (PDTM) - CDM
Laboratory Data	All laboratory data will be verified by the laboratory performing the analysis for completeness and technical accuracy prior to submittal to EPA. Subsequently, EPA or its contractor will evaluate the data packages for completeness and compliance. Table 9 of the IDQTF UFP-QAPP shows items for compliance review.	External	Laboratory manager or QA Officer - TBD ESAT or EPA validator
Electronic Data Deliverables (EDDs)	Determine whether required fields and format were provided.	Internal	Melinda Olsen - CDM
QAPP	All planning documents will be available to reviewers to allow reconciliation with planned activities and objectives.	Internal	All data users

QAPP Worksheet #35
Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
IIa	Methods	Records support implementation of the SOP - sampling and analysis	EPA (Environmental Services Assistance Team [ESAT] or DESA) CDM will validate any subcontract laboratory generated data. This form will be resubmitted if a subcontract laboratory is needed.
IIa	Chain of Custody	Examine traceability of data from sample collection to generation of project reported data. Provides sampling dates and time; verification of sample ID; and QC sample information.	
IIb	Data Narrative	Determine deviations from methods and contract and the impact.	
IIb	Audit Report	Reports used to validate compliance of field sampling, handling and analysis activities with the QAPP.	
IIb	Project Quantitation Limit	PQL achieved as outlined in the QAPP and that the laboratory successfully analyzed a standard at the QL.	
IIb	Field and Lab data and QC report	A summary of all QC samples and results will be verified for measurement performance criteria, completeness and 10% verified to field and laboratory data reports from vendors. A report on whether the measurement performance criteria were met will be prepared within 30 days of receipt of data.	
IIb	Data Package	Used to perform data validation on 100% of all CLP data. Any subcontractor analyzed data will be validated by CDM. A report shall be prepared within 30 days of data receipt. Ensure that all analytical procedures were followed. Corrective actions will be taken and documented when applicable per specific methods. Deviations will be documented. Data will be qualified in accordance with specific methods.	

QAPP Worksheet #36
Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (Title, Organization)
IIa /IIb	Monitoring Wells Groundwater Samples	TCL VOCs (Trace), TAL metals, total/dissolved iron, total/dissolved manganese	Low	Region 2 - Data Validation Guidelines SOP HW-13, rev 3.2 for metals and HW-34 (Rev. 1) August 2007 for Trace VOCs	DESA/ESAT
IIa/IIb	Monitoring Wells Groundwater Samples	Hardness, TSS, pH	Low	NA – engineering data, not validated	NA
IIa /IIb	Building Foundation Soil Geotechnical Samples	Grain Size, Moisture Atterberg Limits	Low	NA – engineering data, not validated	NA
IIa /IIb	Recharge Basin Geotechnical Soil Samples	Grain Size	Low	NA – engineering data, not validated	NA

NA – not applicable

QAPP Worksheet #37
Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

The Data Usability Assessment will be performed by a team of personnel at CDM. Scott Kirchner will be responsible for information in the Usability Assessment. She will also be responsible for assigning task work to the individual task members who will be supporting the Data Usability Assessment. Note that the Data Usability Assessment will be conducted on validated data. After the Data Usability Assessment has been performed, data deemed appropriate for use will then be used in the RD. The results of the Data Usability Assessment will be presented in the data evaluation report and RD report. The following items will be assessed and conclusions drawn based on their results.

Precision – Results of laboratory duplicates will be assessed during data validation and data will be qualified according to the data validation procedures cited on Worksheet #36. Field duplicates will be assessed by matrix using the RPD for each pair of results reported above CRQL for organic and inorganic analyses respectively. RPD acceptance criteria, presented in Worksheet #12, will be used to access field sampling precision. Absolute difference will be used for low results as described in worksheets 12 and 28. A discussion summarizing the results of laboratory and field precision and any limitations on the use of the data will be described.

Field duplicates - The site manager will review the extent of exceedance of the field duplicate criteria. For groundwater, the sample results will be flagged according to the data validation protocol. For soils, the exceedances will be compared with the field lithological logs and grain size results, if available. Based on this review, the site manager will determine whether the exceedance is due to inherent soil heterogeneity or the result of sample handling in the field or laboratory. This information will be included in the data assessment report. As an added measure, the field team leader will be asked to inspect the soil coning and quartering procedures and re-train staff if needed. The data assessor will review the data validation report. If the field duplicate comparison is not included, it will be performed by the assessor. Since soil samples will not be validated, the data assessor will perform the field duplicate comparison.

Accuracy/Bias Contamination – Results for all laboratory blanks will be assessed as part of the data validation. During the data validation process the validator will qualify the data following the procedures described on Worksheet #36. A discussion summarizing the results of laboratory accuracy and bias based on contamination will be presented and any limitations on the use of the data will be described.

Overall Accuracy/Bias – The results of instrument calibration and matrix spike recoveries will be reviewed and data will be qualified according to the data validation procedures cited on Worksheet #36. A discussion summarizing the results of laboratory accuracy and any limitations on the use of the data will be described.

Sensitivity – Data results will be compared to criteria provided on Worksheet #15. A discussion summarizing any conclusions about sensitivity of the analyses will be presented and any limitations on the use of the data will be described.

Representativeness – A review of adherence to field procedures and of project QA audits will be performed in order to assess the representativeness of the sampling program. Data validation narratives will also be reviewed and any conclusions about the representativeness of the data set will be discussed. The data will be evaluated to determine if the plume has been defined to proceed with design of the remedy. If contamination in SVP-9 is very low then the data

QAPP Worksheet #37
Usability Assessment

represent the northern boundary of the plume. If contamination in the deepest port at SVP-10 is very low, then the data represent the deepest part of the plume. If contamination in SVP-11 is very low, the data represent the southern boundary of the plume.

Comparability – The results of this study will be used in conjunction with existing data to produce the site reports.

Reconciliation – The DQIs presented in Worksheet #12 will be examined to determine if the MPC were met. This examination will include a combined overall assessment of the results of each analysis pertinent to an objective. Each analysis will first be evaluated separately in terms of major impacts observed from data validation, data quality indicators and measurement performance criteria assessments. Based on the results of these assessments, the quality of the data will be determined. Based on the quality determined, the usability of the data for each analysis will be determined. Based on the combined usability of the data from all analyses for an objective, it will be determined if the DQIs were met and whether project goals were achieved. As part of the reconciliation of each objective, conclusions will be drawn and any limitations on the usability of any of the data will be described. The data will be evaluated to determine if the plume has been defined to proceed with design of the remedy. If contamination in SVP-9 is very low then the data represent the northern boundary of the plume. If contamination in the deepest port at SVP-10 is very low, then the data represent the deepest part of the plume. If contamination in SVP-11 is very low, the data represent the southern boundary of the plume. If these conditions are met, enough information has been obtained to proceed with the remedial design.

Completeness - The Environmental Quality Information Systems (EQuIS) database will be queried to summarize the number of samples in each analytical fraction that are estimated and rejected. These data will be used along with the planned samples indicated in the QAPP to calculate the completeness of the obtained data set. The data will be evaluated to determine if the plume has been adequately defined. The same criteria specified under Reconciliation will be utilized.

Data validation reports will be reviewed to determine the quality of the data and potential impacts on data usability. Field duplicates will be evaluated against the MPCs outlined in worksheet #12. Non-compliant data will be discussed in the usability report. The following equations will be used :

1. To calculate field duplicate precision: $RPD = 100 \times 2 |X1 - X2| / (X1 + X2)$ where X1 and X2 are the reported concentrations for each duplicate or replicate

2. To calculate completeness: $\% \text{ Completeness} = V/n \times 100$ where V= number of measurements judged valid; n = total number of measurements made
And $\% \text{ Completeness} = C/x \times 100$ where C= number of samples collected; x = total number of measurements planned

2. Describe the evaluative procedures used to assess overall measurement error associated with the project:

CDM will determine if quality control data is within specifications (MPC) though the data and data assessment validation process IIb. CDM will determine whether the new multi-port monitoring wells adequately refined the plume boundaries if: (1) SVP-9 has little or no contamination, (2) SVP-10 has little or no contamination in the deepest port, and (3) if SVP-11 has little or no contamination. The results of the geotechnical evaluation in the recharge basin will be used to confirm the basin has adequate recharge capabilities for discharge of the effluent. The results of the geotechnical evaluation at the treatment plant location will confirm that the area can support a building foundation.

3. Identify the personnel responsible for performing the usability assessment: Scott Kirchner, ASC or designee

4. Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

A usability report will describe the rationale for the data used and present any data limitations. The report will include a discussion of the accuracy, precision, representativeness, completeness and comparability of the data set and deviations from planned procedures and analysis and the impact on the project objectives. Tables will be prepared, including: a summary of planned samples, collected samples and parameters analyzed; detections in field and trip blanks; comparison of field duplicates; and a comparison of planned and actual detection limits.

The following procedures will be followed for using data in preparing the Remedial Design Report:

- Defining the nature and extent of contamination - CDM will evaluate individual sample results for the Remedial Design Report. The sample results will be compared to the site-specific screening criteria defined as project action limits on Worksheet # 15.
- Identifying data gaps - Data gaps will be identified at the end of the field investigation, while developing the data evaluation technical memorandum and while writing the RD Report. As soon as data gaps are identified, CDM will discuss them with EPA. To identify data gaps, CDM will evaluate the analytical results by media and determine if results indicate levels or locations of contamination that need to be further delineated.
- Using qualified data - CDM utilizes all data not rejected during validation to refine the VOC plume boundaries and other data uses.
- Deciding if high results are legitimate or outliers - CDM will assume that all data not rejected during validation will be considered in refining the nature and extent of contamination at the site. CDM will work with EPA if there is a concern about the statistical validity of the sample results. In particular, high "outlier" results with no surrounding comparable results as confirmation will be discussed with EPA.

Glossary of Abbreviations

% recovery	percent recovery
1,1-DCE	1,1-dichloroethene
cis-1,2-DCE	cis-1,2-dichloroethene
ABS	absolute difference
AES	atomic emission spectrometer
ANSETS	analytical services tracking system data requirement
ASC	Analytical Services Coordinator
ASQ	American Society for Quality
ASTM	American Society of Testing and Materials
bgs	below ground surface
^0C	degrees Celsius
CA	corrective action
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CLP	Contract Laboratory Program
CRQL	contract required quantitation limits
CY	cubic yards
DAF	dilution attenuation factor
DESA	Division of Environmental Science and Assessment
DMC	deuterated monitoring compound
DQI	data quality indicator
DQO	data quality objective
EDDs	electronic data deliverables
EERS	EPA's Emergency Response and Removal Section
Eh	oxidation-reduction potential
EPA	United States Environmental Protection Agency
EQuIS	Environmental Quality Information Systems
ESAT	Environmental Services Assistance Team
FASTAC	Field and Analytical Services Teaming Advisory Committee
FCR	field change request
FS	feasibility study
FTL	Field Team Leader
FTM	Field Task Manager
GAC	granular activated carbon
GC/MS	gas chromatograph/mass spectrometer
GIS	geographic information system
gpm	gallons per minute
HASP	Health and Safety Plan
H&S	health and safety
HACH	HACH Company
HCl	hydrochloric acid
HHRA	human health risk assessment
HNO_3	nitric acid
H_2SO_4	sulfuric acid
IBC	International Building Code
ID	identification
IDW	Investigation derived waste
ISCO	in situ chemical oxidation
ITRC	Interstate Technology & Regulatory Council
kcps	thousand counts per second
kg	kilogram
L	liter
LCS	laboratory control sample

LCSD	laboratory control sample duplicate
LDL	low detection limit
LEL	lower explosive limit
M&TE	measurement and test equipment
m^3	cubic meter
MCAWW	Method for Chemical Analysis of Water and Wastes
MCL	maximum contaminant level
MD	matrix duplicate
MDL	method detection limit
mg/kg	milligrams per kilogram
mg	milligram
mL	milliliter
MNA	monitored natural attenuation
MPC	measurement performance criteria
MS	matrix spike
MS/MSD	matrix spike/matrix spike duplicate
msl	mean sea level
N/A	not applicable
NIST	National Institute for Standards and Technology
NPDWS	EPA National Primary Drinking Water Standards
NRWQC	national recommended water quality criteria
NTU	nephelometric turbidity units
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OSHA	Occupation Safety and Health Administration
PCE	tetrachloroethylene
PE	professional engineer
PES	performance evaluation sample
PG	Project Geologist
PID	photoionization detector
ppb	parts per billion
ppbv	parts per billion by volume
ppm	parts per million
PQL	project quantitation limit
PQLG	project quantitation limit goals
PQO	project quality objective
PTFE	polytetrafluoroethylene
PVC	polyvinyl chloride
Q	well yields
QA/QC	quality assurance/quality control
QA	quality assurance
QAC	Quality Assurance Coordinator
QAPP	Quality Assurance Project Plan
QAR	quality assurance requirement
QC	quality control
QL	quantitation limit
R1	round 1
R2	round 2
RAC II	Response Action Contract Region 2
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
RI	remedial investigation
ROD	record of decision
RPD	relative percent difference
RPM	Remedial Project Manager

RQAC	Regional Quality Assurance Coordinator
RSCC	Regional Sample Control Center
RSD	relative standard deviation
SA	self assessment
S&A	Sampling and Analytical
SAT	site assessment team
SB	soil boring
SDRI	double ring infiltraometer
SM	site manager
SOP	Standard Operating Procedures
SOW	Statement of Work
SQL	sample quantitation limit
T	aquifer transmissivity
TAL	Target Analyte List
TAT	turn around time
TBD	to be determined
TCE	trichloroethene
TCL	Target Compound List
temp	temperature
TKN	total Kjehldahl nitrogen
TM	technical memorandum
TOC	total organic carbon
TSOP	Technical Standard Operating Procedure
TS	treatability study
TSS	total suspended solids
µg/kg	micrograms per kilograms
µg/L	micrograms per liter
µS	micro Siemens
VOA	volatile organic analysis
VOC	volatile organic compound
VTSR	verified time of sample receipt

References

ASTM D 422-63(2002)e1, "Standard Test Method for Particle-Size Analysis of Soils," ASTM International. http://www.astm.org.

ASTM D 1586-99, "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils," ASTM International. http://www.astm.org.

ASTM D 2216-05, "Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass," ASTM International. http://www.astm.org.

ASTM D 2434-68(2006), "Standard Test Method for Permeability of Granular Soils (Constant Head)," ASTM International. http://www.astm.org.

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CDM 2007a. Final Remedial Investigation Report, Old Roosevelt Field Contaminated Groundwater Area Site, Garden City, New York, July.

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New York State Department of Environmental Conservation (NYSDEC). 1998. NYSDEC Technical Operational Guidance, 6 NYCRR Chapter X Part 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations. June. Amended 1999, 2000, 2004. http://www.epa.gov/safewater/contaminants/index.html#organic

_______. 1998. NYSDEC Technical Operational Guidance Part 701: Classifications-Surface Waters and Groundwaters http://www.dec.ny.gov/regs/4592.html.

Westbay. 2003. Sampling Protocol. July 7.

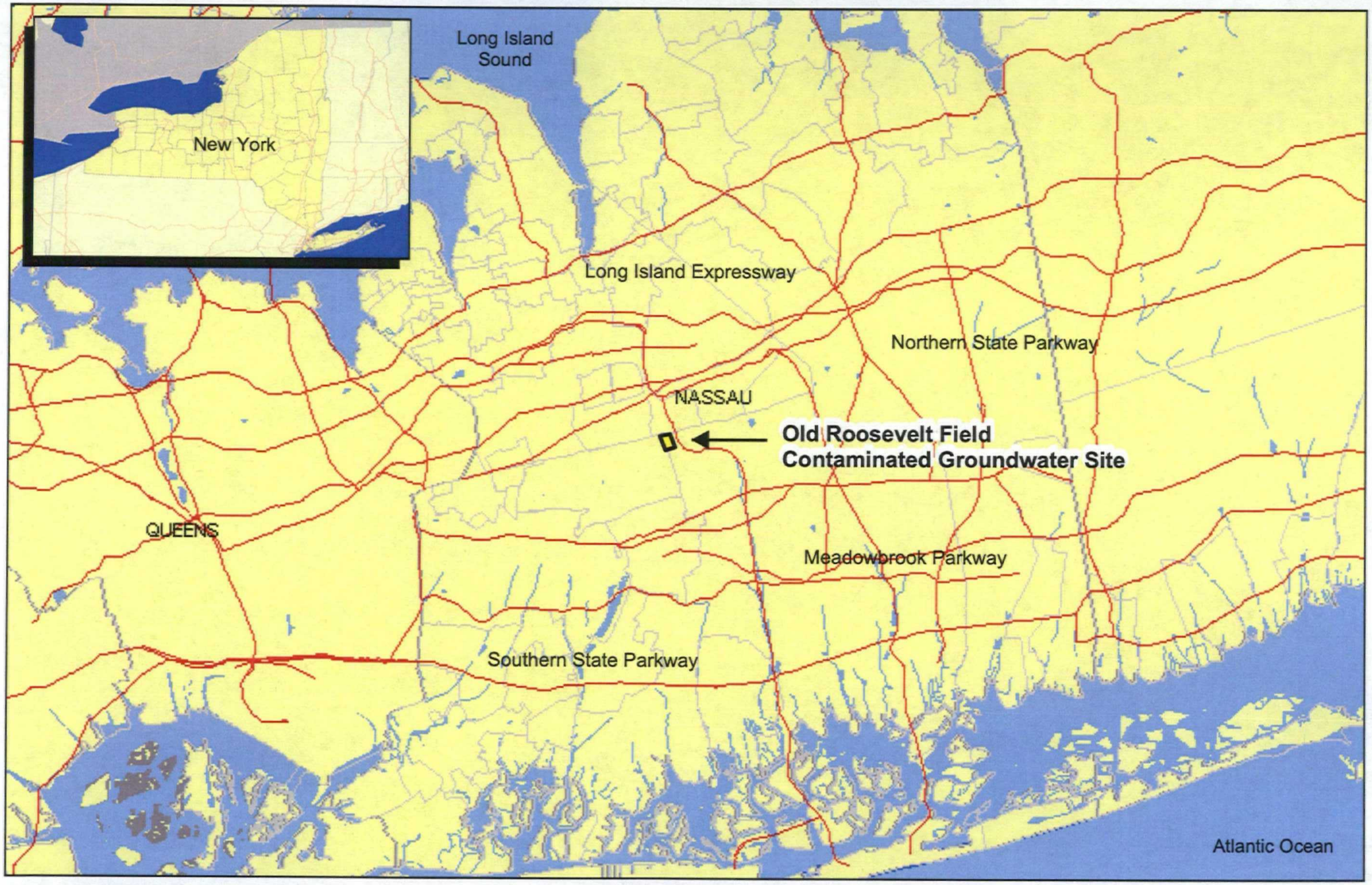
TABLES

Table 1
Multi-port Monitoring Well Screen Intervals
Old Roosevelt Field Contaminated Groundwater Area Site
Garden City, New York

<table>
<tr><th>No.</th><th>Location and Rationale</th><th>Number of Ports</th><th>Proposed Screen Intervals (feet bgs)</th></tr>
<tr><td>SVP-9</td><td>North of existing well 9943 to define the northern boundary of contamination</td><td>10</td><td rowspan="3">Port 10: 45-50
Port 9: 100-105
Port 8: 145-150
Port 7: 185-190
Port 6: 245-250
Port 5: 285-290
Port 4: 305-310
Port 3: 305-310
Port 2: 400-405
Port 1: 480-485</td></tr>
<tr><td>SVP-10</td><td>Near existing well 10019 to define the depth of contamination in the hot spot</td><td>10</td></tr>
<tr><td>SVP-11</td><td>Near southwest corner of Nassau Recharge Basin #124 (on Stewart Avenue School property) to determine if contamination is present south of the supply wells</td><td>10</td></tr>
</table>

Abbreviations: bgs = below ground surface

FIGURES



adapted from NYSDEC Interactive Mapping Gateway: http://www.nygis.state.ny.us/gateway/index.html

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Figure 1

Site Location Map

Old Roosevelt Field Contaminated Groundwater Area Site
Garden City, New York

adapted from NYSDEC Interactive Mapping Gateway: http://www.nygis.state.ny.us/gateway/index.html

Groundwater flow direction

Approximate aerial extent of current VOC Plume

0.25 0.125 0 0.25 Miles

Figure 2

Site Features Map

Old Roosevelt Field Contaminated Groundwater Site

Nassau County, New York

CDM

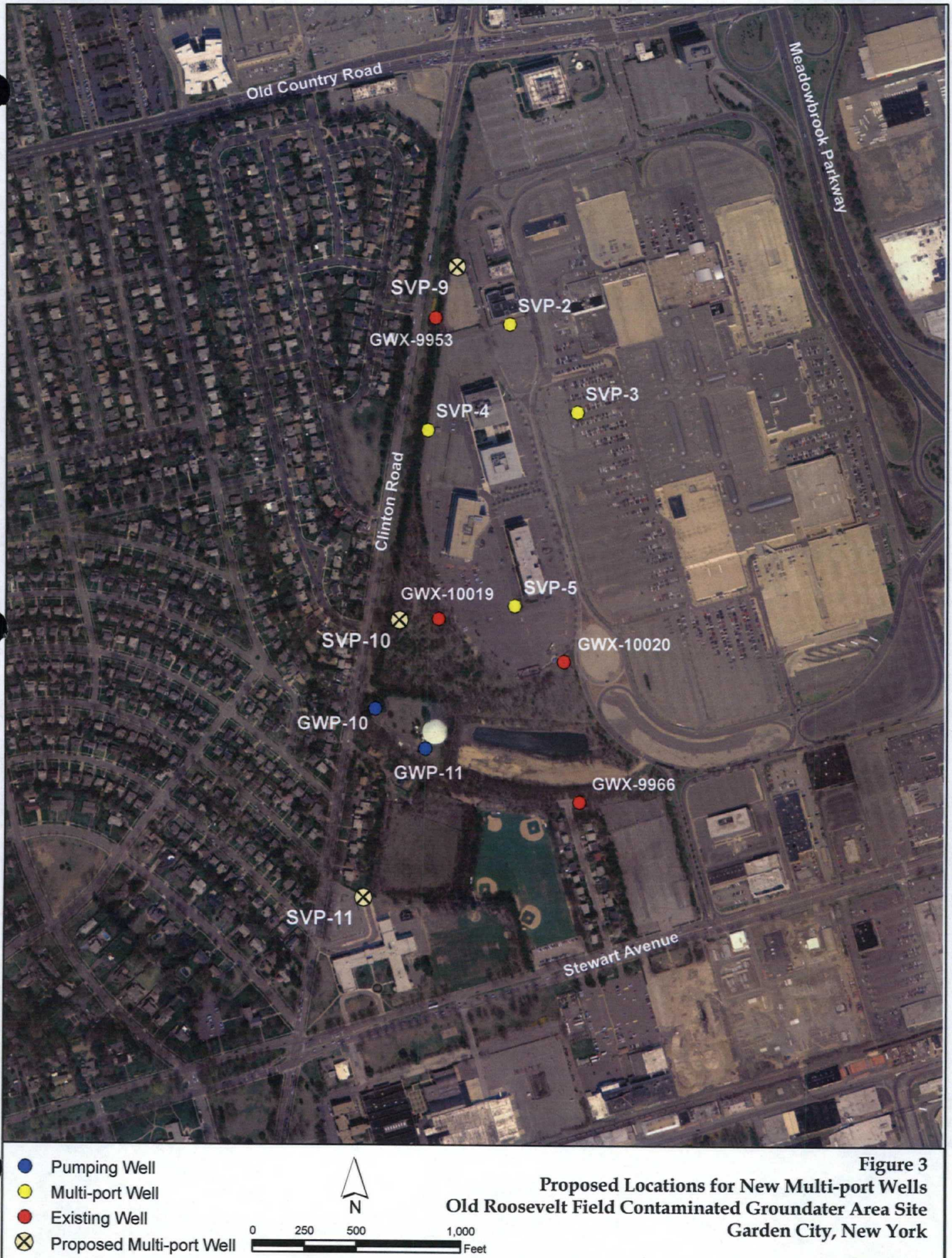
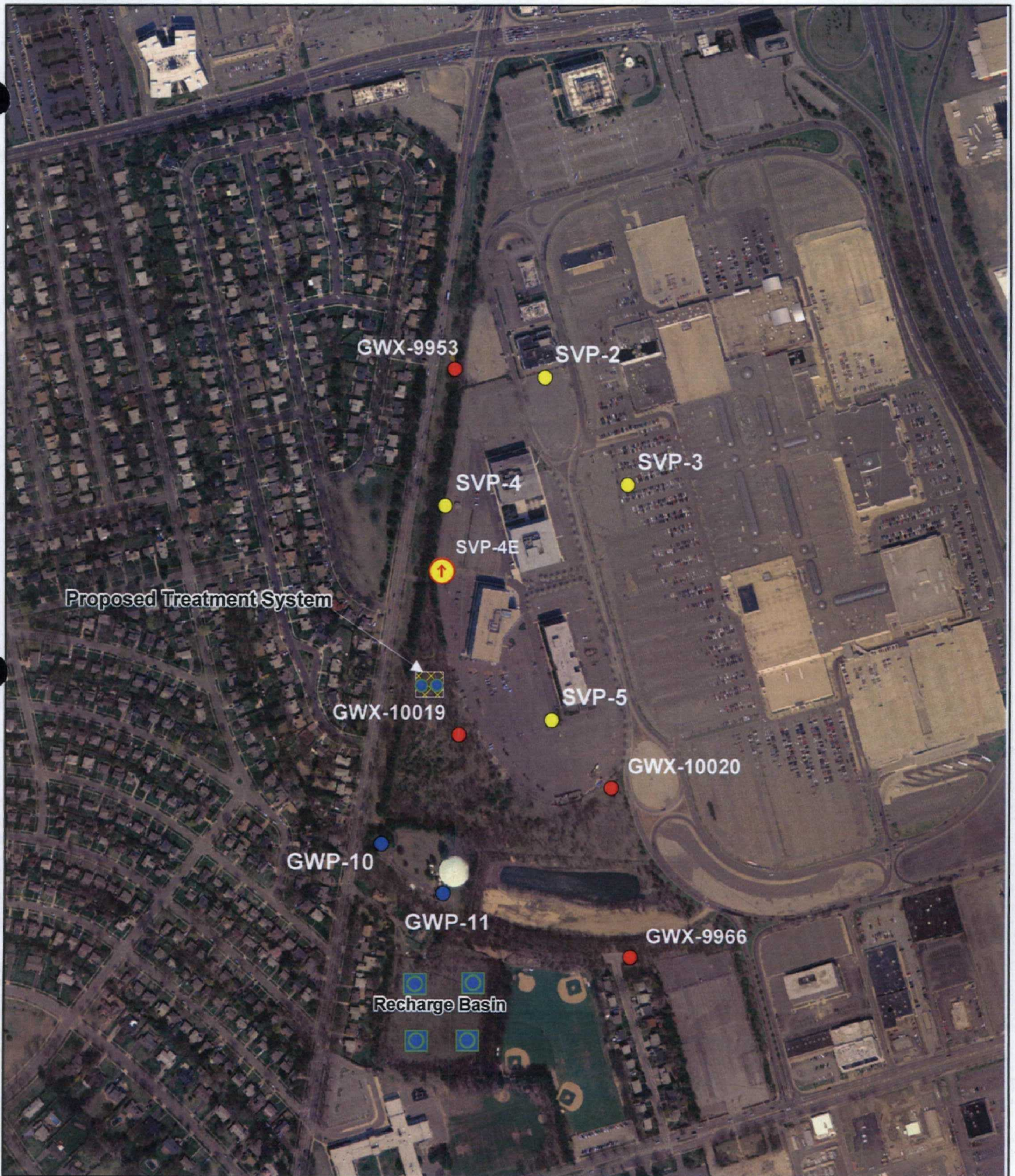


Figure 3
Proposed Locations for New Multi-port Wells
Old Roosevelt Field Contaminated Groundater Area Site
Garden City, New York

CDM



Pumping Well
Multi-port Well
Existing Well
Extraction Well
Recharge Basin Percolation Test/Geotechnical Boring Location
Treatment Facility Geotechnical Boring Location

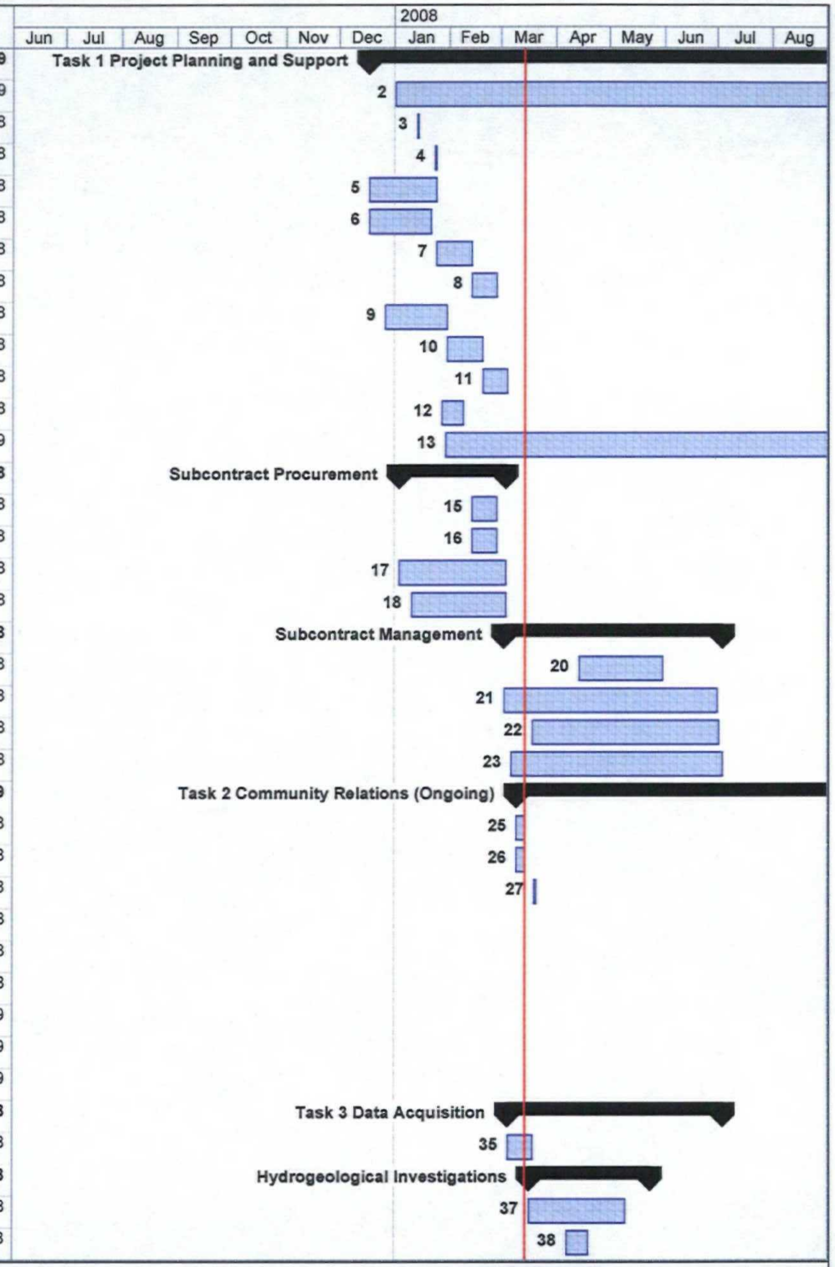
N

0 250 500 1,000 Feet

Figure 4
Proposed Soil Boring Locations
Old Roosevelt Field Contamination Groundwater Area Site
Garden City, New York

CDM

ID	Task Name	Task	Duration	Start	Finish
1	**Task 1 Project Planning and Support**		**509 days**	**12/18/07**	**11/27/09**
2	Project Administration	1.1	498 days	1/2/08	11/27/09
3	Attend Scoping Meetings	1.2	1 day	1/14/08	1/14/08
4	Conduct Site Visit	1.3	1 day	1/24/08	1/24/08
5	Develop Daft Work Plan and Associated Cost Estimate	1.4	28 days	12/18/07	1/24/08
6	Evaluate Existing Data and Documents	1.6	25 days	12/18/07	1/21/08
7	EPA Review of Work Plan		14 days	1/25/08	2/13/08
8	Negotiate and Revise Draft Work Plan/Budget	1.5	10 days	2/14/08	2/27/08
9	Prepare Draft QAPP	1.7	25 days	12/27/07	1/30/08
10	EPA Review of Draft QAPP		14 days	1/31/08	2/19/08
11	Prepare/Submit Final QAPP	1.7	10 days	2/20/08	3/4/08
12	Prepare/Submit HASP	1.8	10 days	1/28/08	2/8/08
13	Meeting (ongoing support)	1.10	436 days	1/30/08	9/30/09
14	**Subcontract Procurement**	**1.11**	**42 days**	**1/4/08**	**3/3/08**
15	1. Surveying		10 days	2/14/08	2/27/08
16	2. Cultural Resources		10 days	2/14/08	2/27/08
17	3. Drilling Services		42 days	1/4/08	3/3/08
18	4. Investigation Derived Waste Disposal		37 days	1/11/08	3/3/08
19	**Subcontract Management**	**1.12**	**89 days**	**3/3/08**	**7/3/08**
20	1. Surveying		35 days	4/14/08	5/30/08
21	2. Cultural Resouces		86 days	3/3/08	6/30/08
22	3. Drilling Services		15 wks	3/19/08	7/1/08
23	4. Investigation Derived Waste Disposal		17 wks	3/7/08	7/3/08
24	**Task 2 Community Relations (Ongoing)**		**378 days**	**3/10/08**	**8/19/09**
25	Public Notices	2.5	5 days	3/10/08	3/14/08
26	Fact Sheet	2.4	5 days	3/10/08	3/14/08
27	Public Meeting Support - Pre-Design	2.3	1 day	3/20/08	3/20/08
28	Public Notices	2.5	5 days	10/15/08	10/21/08
29	Fact Sheet	2.4	5 days	10/15/08	10/21/08
30	Public Meeting Support - Pre-Final Design	2.3	1 day	10/22/08	10/22/08
31	Public Notices	2.5	5 days	8/12/09	8/18/09
32	Fact Sheet	2.4	5 days	8/12/09	8/18/09
33	Public Meeting Support - Final Design	2.3	1 day	8/19/09	8/19/09
34	**Task 3 Data Acquisition**		**87 days**	**3/5/08**	**7/3/08**
35	Mobilization	3.1	10 days	3/5/08	3/18/08
36	**Hydrogeological Investigations**	**3.2**	**50 days**	**3/17/08**	**5/23/08**
37	Multi-Port Well Installation	3.2	40 days	3/17/08	5/9/08
38	Geotechnical Borings and Testing	3.2	10 days	4/7/08	4/18/08

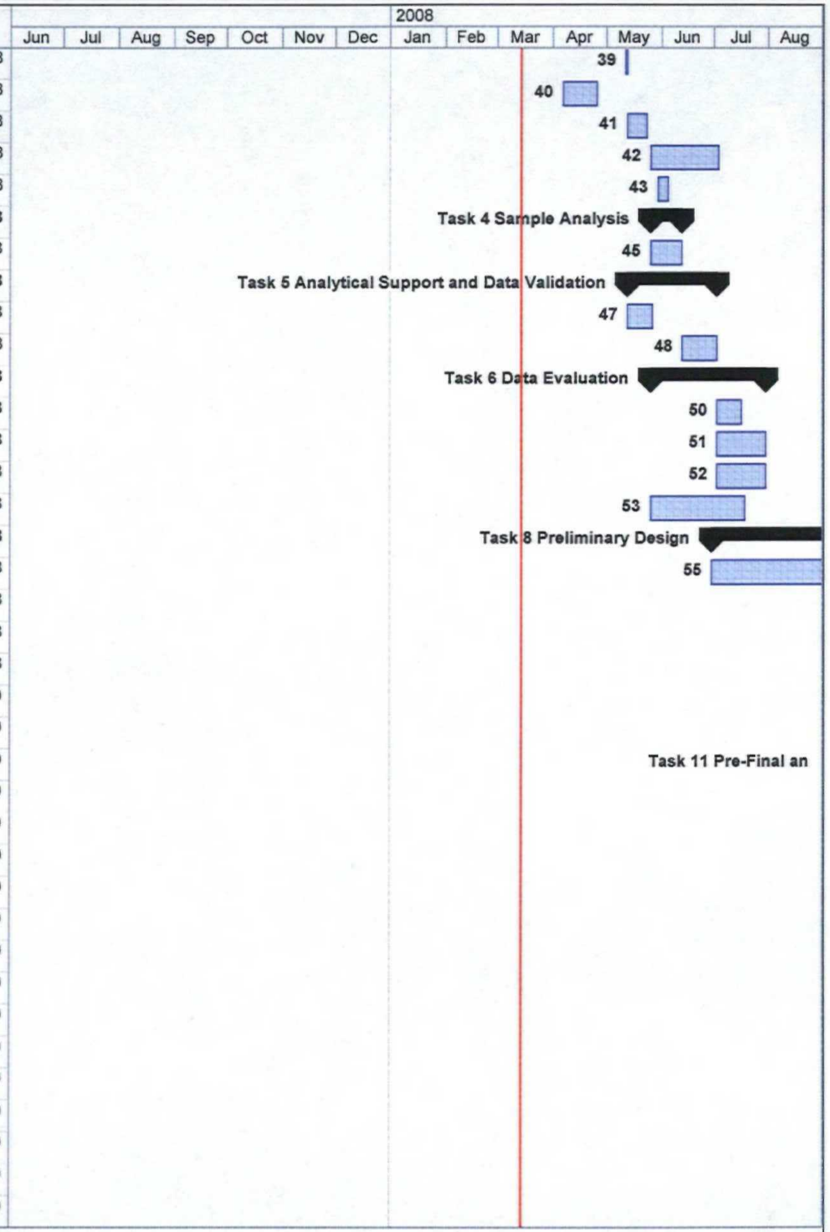


Date: 3/14/08 | Task | Split | Progress | Milestone | Summary

Figure 5
Remedial Design Schedule
Old Roosevelt Field Contaminated Groundwater Area Site Garden City, New York

CDM

ID	Task Name	Task	Duration	Start	Finish
39	Synoptic Water Level Measurements	3.2	1 day	5/12/08	5/12/08
40	Continuous Water Level Monitoring	3.2	3 wks	4/7/08	4/25/08
41	Monitoring Well Sampling	3.2	9 days	5/13/08	5/23/08
42	IDW Characterization and Disposal	3.3	29 days	5/26/08	7/3/08
43	Demobilization	3.1	4 days	5/30/08	6/4/08
44	**Task 4 Sample Analysis**		**14 days**	**5/26/08**	**6/12/08**
45	CLP Analyses	4.2	14 days	5/26/08	6/12/08
46	**Task 5 Analytical Support and Data Validation**		**37 days**	**5/13/08**	**7/2/08**
47	Prepare and Ship Samples	5.1	10 days	5/13/08	5/26/08
48	Data Validation by EPA	5.2	14 days	6/13/08	7/2/08
49	**Task 6 Data Evaluation**		**48 days**	**5/26/08**	**7/30/08**
50	Data Usability Evaluation	6.1	10 days	7/3/08	7/16/08
51	Data Reduction, Tabulation, and Evaluation	6.2	20 days	7/3/08	7/30/08
52	Data Evaluation Report	6.3	20 days	7/3/08	7/30/08
53	Groundwater Modeling	6.4	40 days	5/26/08	7/18/08
54	**Task 8 Preliminary Design**		**110 days**	**6/30/08**	**11/28/08**
55	Preliminary Design	8.1	75 days	6/30/08	10/10/08
56	Preliminary Design Meeting	8.1	1 day	10/10/08	10/10/08
57	EPA Review		30 days	10/13/08	11/21/08
58	Respond to EPA Comments	8.1	5 days	11/24/08	11/28/08
59	**Task 9 Equipment, Services, and Utilities**		**106 days**	**4/6/09**	**8/31/09**
60	Identify Long-Lead Equipment, Services, and Utilities	9.1	106 days	4/6/09	8/31/09
61	**Task 11 Pre-Final and Final Design**		**174 days**	**11/10/08**	**7/9/09**
62	Pre-Final Specifications and Drawings	11.1	80 days	11/10/08	2/27/09
63	Pre-Final RA Cost Estimate	11.2	15 days	3/9/09	3/27/09
64	Pre-Final Design Review Meeting	11.3	1 day	4/1/09	4/1/09
65	EPA Review		30 days	3/30/09	5/8/09
66	Prepare Final Design Submittal	11.4	30 days	5/11/09	6/19/09
67	Prepare Final RA Cost Estimate	11.2	14 days	6/22/09	7/9/09
68	RA Subcontract Documents	11.5	14 days	6/22/09	7/9/09
69	Operation and Maintenance (O&M) Plan	11.6	14 days	6/22/09	7/9/09
70	**Task 12 Post-Remedial Design Support (Optional)**		**30 days**	**7/20/09**	**8/28/09**
71	Update Final Design Plans and Specifications (Optional)	12.1	30 days	7/20/09	8/28/09
72	**Task 13 Work Assignment Closeout**		**45 days**	**9/28/09**	**11/27/09**
73	Submission of RD Documents to EPA	13.1	15 days	9/28/09	10/16/09
74	File Archiving and Storage	13.2	15 days	10/19/09	11/6/09
75	Work Assignment Closeout Report	13.3	15 days	11/9/09	11/27/09



Date: 3/14/08 | Task | Split | Progress | Milestone | Summary

CDM

Figure 5
Remedial Design Schedule
Old Roosevelt Field Contaminated Groundwater Area Site Garden City, New York

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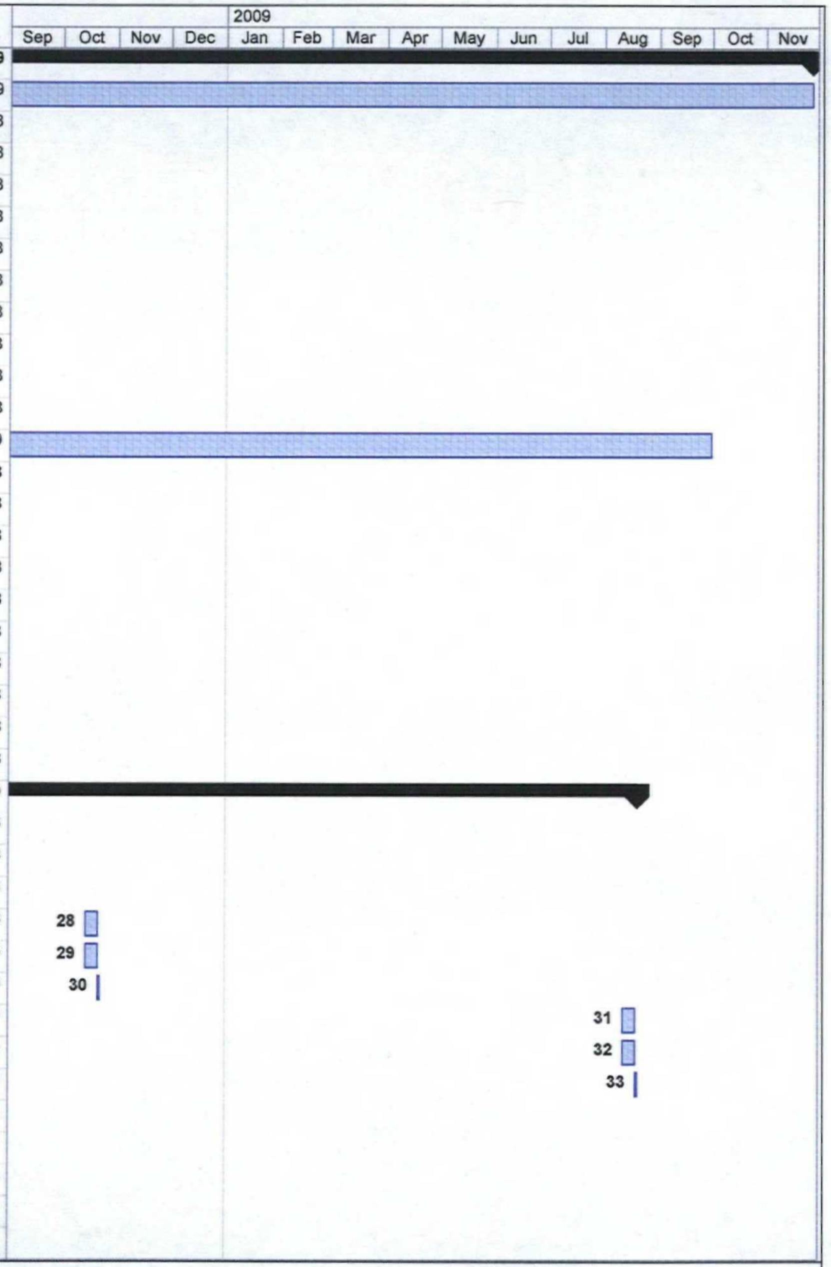
25	Public Notices	2.5	5 days	3/10/08	3/14/08
26	Fact Sheet	2.4	5 days	3/10/08	3/14/08
27	Public Meeting Support - Pre-Design	2.3	1 day	3/20/08	3/20/08
28	Public Notices	2.5	5 days	10/15/08	10/21/08
29	Fact Sheet	2.4	5 days	10/15/08	10/21/08
30	Public Meeting Support - Pre-Final Design	2.3	1 day	10/22/08	10/22/08
31	Public Notices	2.5	5 days	8/12/09	8/18/09
32	Fact Sheet	2.4	5 days	8/12/09	8/18/09
33	Public Meeting Support - Final Design	2.3	1 day	8/19/09	8/19/09
34	**Task 3 Data Acquisition**		**87 days**	**3/5/08**	**7/3/08**
35	Mobilization	3.1	10 days	3/5/08	3/18/08
36	**Hydrogeological Investigations**	**3.2**	**50 days**	**3/17/08**	**5/23/08**
37	Multi-Port Well Installation	3.2	40 days	3/17/08	5/9/08
38	Geotechnical Borings and Testing	3.2	10 days	4/7/08	4/18/08

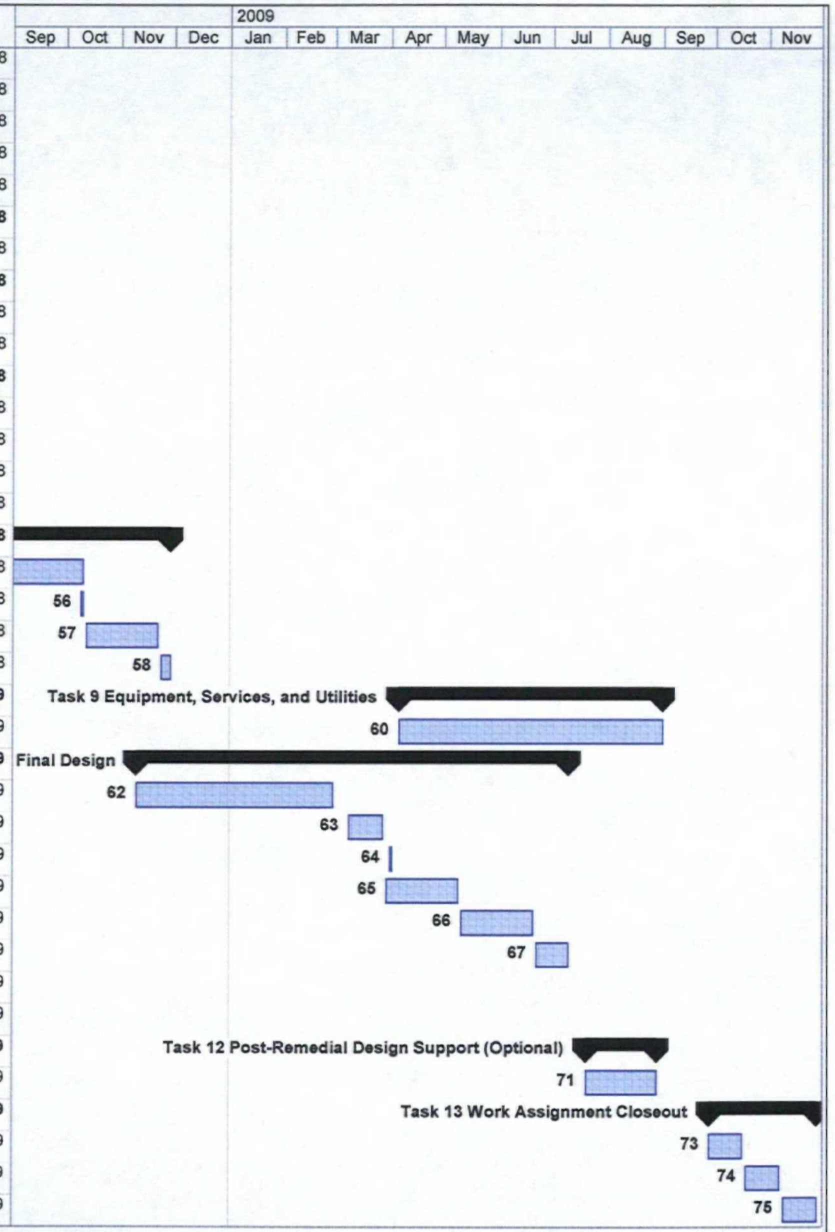


Date: 3/14/08 | Task | Split | Progress | Milestone | Summary

CDM

Figure 5
Remedial Design Schedule
Old Roosevelt Field Contaminated Groundwater Area Site Garden City, New York

ID	Task Name	Task	Duration	Start	Finish
39	Synoptic Water Level Measurements	3.2	1 day	5/12/08	5/12/08
40	Continuous Water Level Monitoring	3.2	3 wks	4/7/08	4/25/08
41	Monitoring Well Sampling	3.2	9 days	5/13/08	5/23/08
42	IDW Characterization and Disposal	3.3	29 days	5/26/08	7/3/08
43	Demobilization	3.1	4 days	5/30/08	6/4/08
44	**Task 4 Sample Analysis**		**14 days**	**5/26/08**	**6/12/08**
45	CLP Analyses	4.2	14 days	5/26/08	6/12/08
46	**Task 5 Analytical Support and Data Validation**		**37 days**	**5/13/08**	**7/2/08**
47	Prepare and Ship Samples	5.1	10 days	5/13/08	5/26/08
48	Data Validation by EPA	5.2	14 days	6/13/08	7/2/08
49	**Task 6 Data Evaluation**		**48 days**	**5/26/08**	**7/30/08**
50	Data Usability Evaluation	6.1	10 days	7/3/08	7/16/08
51	Data Reduction, Tabulation, and Evaluation	6.2	20 days	7/3/08	7/30/08
52	Data Evaluation Report	6.3	20 days	7/3/08	7/30/08
53	Groundwater Modeling	6.4	40 days	5/26/08	7/18/08
54	**Task 8 Preliminary Design**		**110 days**	**6/30/08**	**11/28/08**
55	Preliminary Design	8.1	75 days	6/30/08	10/10/08
56	Preliminary Design Meeting	8.1	1 day	10/10/08	10/10/08
57	EPA Review		30 days	10/13/08	11/21/08
58	Respond to EPA Comments	8.1	5 days	11/24/08	11/28/08
59	**Task 9 Equipment, Services, and Utilities**		**106 days**	**4/6/09**	**8/31/09**
60	Identify Long-Lead Equipment, Services, and Utilities	9.1	106 days	4/6/09	8/31/09
61	**Task 11 Pre-Final and Final Design**		**174 days**	**11/10/08**	**7/9/09**
62	Pre-Final Specifications and Drawings	11.1	80 days	11/10/08	2/27/09
63	Pre-Final RA Cost Estimate	11.2	15 days	3/9/09	3/27/09
64	Pre-Final Design Review Meeting	11.3	1 day	4/1/09	4/1/09
65	EPA Review		30 days	3/30/09	5/8/09
66	Prepare Final Design Submittal	11.4	30 days	5/11/09	6/19/09
67	Prepare Final RA Cost Estimate	11.2	14 days	6/22/09	7/9/09
68	RA Subcontract Documents	11.5	14 days	6/22/09	7/9/09
69	Operation and Maintenance (O&M) Plan	11.6	14 days	6/22/09	7/9/09
70	**Task 12 Post-Remedial Design Support (Optional)**		**30 days**	**7/20/09**	**8/28/09**
71	Update Final Design Plans and Specifications (Optional)	12.1	30 days	7/20/09	8/28/09
72	**Task 13 Work Assignment Closeout**		**45 days**	**9/28/09**	**11/27/09**
73	Submission of RD Documents to EPA	13.1	15 days	9/28/09	10/16/09
74	File Archiving and Storage	13.2	15 days	10/19/09	11/6/09
75	Work Assignment Closeout Report	13.3	15 days	11/9/09	11/27/09



Date: 3/14/08 | Task | Split | Progress | Milestone | Summary

Figure 5
Remedial Design Schedule
Old Roosevelt Field Contaminated Groundwater Area Site Garden City, New York

CDM

Appendix A

APPENDIX A

SITE-SPECIFIC LOW FLOW GROUNDWATER PURGING AND SAMPLING PROCEDURE

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 2

GROUNDWATER SAMPLING PROCEDURE
LOW STRESS (LOW-FLOW) PURGING AND SAMPLING

I. SCOPE & APPLICATION

This Low Stress (or Low-Flow) Purging and Sampling Procedure is the EPA Region 2 preferred method for collecting groundwater samples from single screen monitoring wells at the Old Roosevelt Field Contaminated Groundwater Site. The procedure minimizes stress on the formation and minimizes disturbance of sediment in the well. The procedure applies to monitoring wells that have well casing with an inner diameter of 2.0 inch or greater. It is appropriate for groundwater samples that will be analyzed for volatile and semi-volatile organic compounds (VOC and SVOC), pesticides, polychlorinated biphenyls (PCB), metals, and microbiological and other contaminants in association with any EPA program.

This procedure does not address the collection of non-aqueous phase liquid (NAPL) samples and should be used for aqueous samples only. For sampling NAPLs, the reader is referred to the following EPA publications: DNAPL Site Evaluation (Cohen & Mercer, 1993) and the RCRA Ground-Water Monitoring: Draft Technical Guidance (EPA/530-R-93-001), and references therein.

II. METHOD SUMMARY

The goal of the Low Stress Purging and Sampling procedure is to collect samples that are representative of groundwater conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that allows a maximum drawdown of 0.3 foot.

Sampling at such a low flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well, thereby producing a sample with low turbidity (i.e., low concentration of suspended particles). Typically, this saves time and analytical costs by eliminating the need for collecting and analyzing a filtered sample from the same well. Second, it minimizes aeration of the groundwater during sample collection, which improves the sample quality for VOC analysis. Third, in most cases it significantly reduces the volume of groundwater purged from a well and the costs associated with its proper treatment and disposal.

III. ADDRESSING POTENTIAL PROBLEMS

Problems that may be encountered using this technique include a) difficulty in sampling wells with insufficient yield; b) failure of a key indicator parameter to stabilize; c) cascading of water and formation of air bubbles in the tubing; and d) cross-contamination.

For wells with insufficient yield (i.e., low recharge rate of the well), care should be taken to avoid loss of pressure in the tubing line, cascading through the sand pack, or pumping the well dry. Purging should be interrupted before the water level in the well drops below the top of the pump. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, ground water samples may be obtained with techniques designed for the unsaturated zone, such as lysimeters.

If a key indicator parameter fails to stabilize after 4 hours, one of two options should be considered: a) continue purging in an attempt to achieve stabilization; or b) discontinue purging, collect samples, and document attempts to reach stabilization in the log book. The key indicator parameter for samples to be analyzed for VOCs is dissolved oxygen. The key indicator parameter for all other samples is turbidity.

For cascading and air bubbles in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 inch ID) to ensure that the tubing remains filled with liquid during sampling.

An item that should be checked on a daily basis, is the water within the cooling chamber of the submersible pump. This chamber should always be filled with demonstrated analyte-free water and any leakage from this chamber should be immediately brought to the attention of the person(s) responsible for equipment maintenance so that the appropriate seals can be replaced. Operating the pump with insufficient water in this cooling chamber could result in the pump overheating and/or pump failure. The analyte-free water should be replaced on a daily basis in order to facilitate the mechanical operation of the pump.

IV. EQUIPMENT

- ☐ **Approved site-specific Quality Assurance Project Plan (QAPP).** Generally, the target depth corresponds to just above the mid-point of the most permeable zone in the screened interval. Borehole geologic and geophysical logs can be used to help select the most permeable zone. However, in some cases, other criteria may be used to select the target depth for the pump intake.
- ☐ Well construction data, location map, field data from last sampling event.
- ☐ Polyethylene sheeting.
- ☐ Photo Ionization Detector (PID).
- ☐ Adjustable rate, positive displacement groundwater sampling pump constructed of stainless steel.

- ☐ Interface probe or equivalent device for determining the presence or absence of NAPL.
- ☐ Teflon-lined polyethylene tubing to collect samples for organic and inorganic analysis. Sufficient tubing of the appropriate material must be available so that each well has dedicated tubing.
- ☐ Electronic water level measuring device, 0.01 foot accuracy.
- ☐ Flow measurement supplies (e.g., graduated cylinder and stop watch).
- ☐ Power source (generator).
- ☐ Monitoring instruments for indicator parameters. Redox potential (Eh) and dissolved oxygen must be monitored in-line using an instrument with a continuous readout display. Temperature, pH and specific conductance may be monitored with an in-line monitor. A nephalometer is used to measure turbidity.
- ☐ Decontamination supplies (see Section VII, below).
- ☐ Logbook (see Section VIII, below).
- ☐ Sample bottles.
- ☐ Sample preservation supplies (as required by the analytical methods).
- ☐ Sample tags or labels, chain of custody.
- ☐ Other supplies as specified in the EPA approved field sampling plan/QAPP.

V. SAMPLING PROCEDURES

Pre-Sampling Activities

1. Start at the well known or believed to have the least contaminated groundwater and proceed systematically to the well with the most contaminated groundwater. Check well for damage or evidence of tampering. Record observations.

2. Lay out sheet of polyethylene for monitoring and sampling equipment.

3. Measure VOCs at the rim of the unopened well with a PID or FID instrument and record the reading in the field log book.

4. Remove well cap.

5. Measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field log book.

6. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one.

7. Measure and record the depth to water (to 0.01 ft) in all wells to be sampled before any purging begins. Care should be taken to minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well.

8. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment which has accumulated at the bottom of the well. Record the observations in the log book.

Sampling Procedures

9. Install Pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well to a depth midway within the screen interval for that well. The pump intake must be kept at least two feet above the bottom of the well to prevent disturbance and resuspension of any sediment or DNAPL present in the bottom of the well. Record the depth to which the pump is lowered.

10. Measure Water Level: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

11. Purge Well: Start pumping the well with a rate that varies from 200 to 500 milliliters per minute (ml/min). The water level should be monitored approximately every three to five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

12. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every three to five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

    ±0.1 for pH
    ±3% for specific conductance (conductivity)
    ±10 mv for redox potential
    ±10% for DO and turbidity

    Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

    If pH adjustment is necessary for sample preservation, the amount of acid to be added to each sample vial prior to sampling should be determined, drop by drop, on a separate and equal volume of water (e.g., 40 mls). Groundwater purged from the well prior to sampling can be used for this purpose.

13. Collect Samples: Collect samples at flow rates of between 100 and 250 ml/min or such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. Samples should be collected at the same flow rate at which the indicator parameters stabilized. VOC samples must be collected first, at the lower rate, and directly into pre-preserved sample containers. All sample containers should be filled with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container.

14. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for re-sampling by hanging the tubing inside the well.

15. Measure and record well depth.

16. Close and lock the well.

VI. FIELD QUALITY CONTROL SAMPLES

Quality control samples must be collected to determine if sample collection and handling procedures have adversely affected the quality of the ground water samples. The appropriate EPA Program Guidance was consulted when preparing the field QC sample requirements of the site-specific QAPP.

All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at frequency of one per sample cooler containing VOCs

- ☐ Field duplicate.
- ☐ Equipment blank (not necessary if equipment is dedicated to the well).
- ☐ Trip blank (VOCs only)

Groundwater samples should be collected systematically beginning at wells known or believed to have the lowest level of contamination and proceeding in order to wells known or believed to have the highest level of contamination.

VII. DECONTAMINATION

Sampling equipment must be decontaminated thoroughly each day before use (daily decon) and after each well is sampled (between-well decon). As noted above, wells should be sampled in order from the least contaminated to the most contaminated. Pumps should not be removed from the well between purging and sampling operations. All non-disposable equipment, including the pump (support cable and electrical wires which are in contact with the sample) will be decontaminated as described below.

17. Prior to Sampling Event Decon

Please Note: Steps D through K should only be performed once (for each pump that is to be used) before the commencement of a particular sampling event by a person qualified to disassemble pumps.

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and thoroughly flush other equipment with potable water.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and thoroughly flush other equipment with fresh detergent solution. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.

D) Disassemble pump.

E) Wash pump parts (inlet screen, shaft suction interconnector, motor lead assembly, stator house): Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate detergent solution. Scrub all pump parts with a test tube brush.

F) Rinse pump parts with potable water for five minutes.

G) Rinse the pump parts with demonstrated analyte-free water.

H) Place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO_3).

I) Rinse impeller assembly with potable water for five minutes.

J) Place impeller assembly in a large glass bleaker and rinse with isopropanol.

K) Thoroughly rinse impeller assembly with demonstrated analyte-free water.

18. Daily and Between-Well Decon

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and thoroughly flush other equipment with fresh detergent solution. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.

D) Final Rinse: Operate pump in a deep basin of analyte-free water to pump out 1 to 2 gallons of this final rinse water.

VIII. FIELD LOG BOOK

A field log book must be kept each time ground water monitoring activities are conducted in the field. The field log book should document the following:

- ☐ Well identification number and physical condition.
- ☐ Well depth, and measurement technique.
- ☐ Static water level depth, date, time, and measurement technique.
- ☐ Presence and thickness of immiscible liquid layers and detection method.
- ☐ Collection method for immiscible liquid layers.
- ☐ Pumping rate, drawdown, indicator parameters values, and clock time, at three to five minute intervals; calculate or measure total volume pumped.
- ☐ Well sampling sequence and time of sample collection.
- ☐ Types of sample bottles used and sample identification numbers.
- ☐ Preservatives used.
- ☐ Parameters requested for analysis.
- ☐ Field observations of sampling event.
- ☐ Name of sample collector(s).
- ☐ Weather conditions.
- ☐ QA/QC data for field instruments.
- ☐ Other logbook entries as required in the EPA approved field sampling plan/QAPP.

IX. REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation, C.K. Smoley Press, Boca Raton, Florida.

EPA, 1993, RCRA Ground-Water Monitoring: Draft Technical Guidance, EPA/530-R-93-001.

EPA, 1998, EPA Region 2, Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling, March 16.

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures, EPA/540/S-95/504.

Appendix B

APPENDIX B

CDM TECHNICAL STANDARD OPERATING PROCEDURES

1-2	Sample Custody*
1-4	Subsurface Soil Sampling*
1-6	Water Level Measurement
1-9	Tap Water Sampling
1-10	Field Measurement of Organic Vapors
2-1	Packaging and Shipping of Environmental Samples*
2-2	Guide to Handling of Investigation Derived Waste
3-2	Topographic Survey
3-4	Geophysical Logging, Calibration, and Quality Control
3-5	Lithologic Logging
4-1	Field Logbook Content and Control*
4-2	Photographic Documentation of Field Activities
4-3	Well Development and Purging*
4-4	Design and Installation of Monitoring Wells in Aquifers*
4-5	Field Equipment Decontamination at Nonradioactive Sites
4-8	Environmental Data Management (See Appendix D)
4-9	Aquifer Performance Tests
5-1	Control of Measurement and Test Equipment*

* Includes RAC II Contract-Specific Clarification

TSOP 1-2

SAMPLE CUSTODY

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 1 - 2
Revision: 4
Date: October 10, 2004

SOP Title: **SAMPLE CUSTODY**

QA Review: JBuford

Approved and Issued: JLitwin 11/1/04
Program Manager Signature/Date

Contract No.: RAC II Client: EPA Region II

Reason for Clarification: Make SOP EPA Region II – Specific
Add Forms II Lite Procedures; Sample tags requirement not applicable.

1.0 OBJECTIVE, add (to page 1 of 7):

For the RAC II contract, the sample custody paperwork will also be supplied to the U.S. Environmental Protection Agency (EPA) Region II Regional Sample Contract Laboratory Program (CLP) Coordinator and the Contract Laboratory Analytical Service Support (CLASS) contact. This will include the combination forms generated using the EPA Field Operations Records Management System II Lite (FORMS II Lite™) software and the hand written combination traffic reports & chain of custody records (TR/COCs).

All samples sent through the CLP system are required to be recorded on the FORMS II Lite™ generated combination TR/COC records. Use of hand written TR/COCs must be approved by EPA Regional Sample Control Center (RSCC) prior to use.

4.0 REQUIRED SUPPLIES, add (to page 2 of 7):

If using the FORMS II Lite™ software the following additional equipment will be required:

- FORMS II Lite™ Software
- Computer
- Printer

5.0 PROCEDURES

5.1 Chain-of-Custody

Field Custody, on page 2 of 7 under item 2, replace:

"Complete sample label or tags for each sample, using waterproof ink.", with, "Complete sample labels for each sample using indelible ink or pre-printed labels."

Add, before 5.2 Sample Labels and Tags (on page 5 of 7):

Procedure for Generating EPA's FORMS II Lite™ Combination Forms

FORMS II Lite™ is used to automate printing of sample documentation in the field and facilitate electronic capture of data prior to and during field sampling activities. FORMS II Lite™ can be populated with the general site information, laboratory information, CLP case number, sample locations, CLP sample numbers, analysis, preservatives, etc. prior to the sampling event. Sample labels can then be generated from FORMS II Lite™.

The following is a list of items required to be entered into FORMS II Lite™:

- Site spill number
- Region number, sampling entity, sampler name and signature
- Type of activity
- Date shipped, courier and air bill number
- Analytical laboratory name, address and contact
- Case number
- CLP sample number
- Sample description (media type)
- Sample concentration (low, medium, high)
- Sample type (composite, grab)
- Preservative used
- Turn-around time (for organic analysis only)
- Routine Analytical Services (RAS) fraction(s)
- Date and time of sample collection
- Sampler's initials
- Corresponding CLP inorganic CLP sample number, if applicable
- Field QC sample information (information regarding trip or field blanks but not reference to duplicate samples)
- Whether shipment for case is complete
- Sample designated for matrix spike laboratory QC purposes

The procedures for generating the FORMS II Lite™ combination forms are similar to preparing the CLP RAS combination forms detailed in the next section. The difference is the information will be entered into the FORMS II Lite™ software and the combination forms will be printed out on site instead of filling in the combination forms in by hand.

Detailed procedures for using the FORMS II Lite™ software are provided in the FORMS II Lite™ User's Guide supplied with the software.

After completing the day's sampling, the date, time and field QC sample information are entered into the FORMS II Lite™ software. Samples are assigned to the traffic reports, shipping information is entered and the traffic reports are printed. The software generates a Region and a Laboratory copy of the TR/COC record. The Laboratory copies of the TR/COC records are signed and placed in a zip-lock bag taped to the inside cooler lid and shipped with the samples to the laboratory. The Region copies of the TR/COC records are submitted to the RSCC and to CLASS along with the sampling trip report. Examples of TR/COC records that FORMS II Lite™ generates for the Laboratory copies (Figures C1 and C2) and the Region copies (Figures C3 and C4) are attached to this Contract-Specific Clarification. A copy of the sampling trip report is made and retained for the CDM RAC II files.

Procedure for Completing EPA CLP RAS Combination Forms

A combination Organic or Inorganic TR/COC record is a four-page carbonless form (Figures C5and C6). The information that must be entered in the combination forms is detailed in the *Contract Laboratory Program (CLP) Guidance for Field Samplers* (EPA/540/R-00/003). A copy of this guidance is to be on site. Field quality control blanks and matrix spike samples will be noted on the combinations forms.

Each sample will be assigned a CLP identification number that will be written or pre-printed on the sample label and affixed in the field to each container for CLP analysis. This unique number, which is recorded on the combination form, is used by EPA to identify the sample. Notations will be made if the sample is to be used as the matrix spike/matrix spike duplicate (organics), matrix spike/duplicate (inorganics), a field (rinsate) blank or trip blank. The same information required to be entered into FORMS II Lite™ is also required on hand written combination Organic or Inorganic TR/COC.

After completing the day's sampling, the bottom two copies of each completed combination form are placed in a zip-lock bag taped to the inside cooler lid and shipped with the samples to the laboratory. The top copy is submitted to the RSCC and the second copy is submitted to CLASS along with the sampling trip report. A copy of each combination form is made and retained for the CDM RAC II files.

5.2 Sample Labels and Tags, (on page 5 of 7)

It should be noted that sample tags are no longer required for Region II CLP samples. Therefore, Figure 2 on page 6 of 7 is not applicable.

7.0 REFERENCES, add (on page 7 of 7):

Environmental Protection Agency (EPA). 1989. *Region II CERCLA Quality Assurance Manual.* Revision 1. EPA Monitoring Management Branch of the Environmental Services Division. October 1989.

_______. 2002. *FORMS II Lite™ User's Guide, Version 5.1.*

_______. 2004. *Contract Laboratory Program (CLP), Guidance for Field Samplers.* EPA-R-00-003. Final. EPA-540-R-00-003. August.

Prepared:	David O. Johnson	**Technical Review:**	S. Budney
QA Review:	Jo Nell Mullins	**Approved:**	E-Signed by Michael C. Malloy VERIFY authenticity with ApproveIt — Signature/Date
Issued:	E-Signed by P. Michael Schwan VERIFY authenticity with ApproveIt — Signature/Date		

1.0 Objective

Because of the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are introduced as evidence in legal proceedings. To maintain and document sample possession, sample custody procedures are followed. All paperwork associated with the sample custody procedures will be retained in CDM Federal Programs Corporation (CDM) files unless the client requests that it be transferred to them for use in legal proceedings or at the completion of the contract.

Note: Sample custody documentation requirements vary with the specific EPA region or client. This SOP is intended to present basic sample custody requirements, along with common options. Specific sample custody requirements shall be presented in the project-specific quality assurance (QA) project plan or project-specific modification or clarification form (see Section U-1).

2.0 Background

2.1 Definitions

Sample - A sample is material to be analyzed that is contained in single or multiple containers representing a unique sample identification number.

Sample Custody - A sample is under custody if:

1. It is in your possession
2. It is in your view, after being in your possession
3. It was in your possession and you locked it up
4. It is in a designated secure area

Chain-of-Custody Record - A chain-of-custody record is a form used to document the transfer of custody of samples from one individual to another.

Custody Seal - A custody seal is a tape-like seal that is part of the chain-of-custody process and is used to detect tampering with samples after they have been packed for shipping.

Sample Label - A sample label is an adhesive label placed on sample containers to designate a sample identification number and other sampling information.

Sample Tag - A sample tag is attached with string to a sample container to designate a sample identification number and other sampling information. Tags may be used when it is difficult to physically place adhesive labels on the container (e.g., in the case of small air sampling tubes).

3.0 General Responsibilities

Sampler - The sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that strict chain-of-custody procedures are maintained during all sampling events. The FTL is also responsible for coordinating with the subcontractor laboratory to ensure that adequate information is recorded on custody records. The FTL determines whether proper custody procedures were followed during the fieldwork.

Field Sample Custodian - The field sample custodian, when designated by the FTL, is responsible for accepting custody of samples from the sampler(s) and properly packing and shipping the samples to the laboratory assigned to do the analyses. A field sample custodian is typically designated only for large and complex field efforts.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Supplies

- Chain-of-custody records (applicable client or CDM forms)
- Sample labels and/or tags
- EPA Field Operations Records Management System II Lite™ (FORMS II Lite™) software (if required)
- Printer paper
- Custody seals
- Clear tape
- Computer
- Printer

5.0 Procedures

5.1 Chain-of-Custody Record

This procedure establishes a method for maintaining custody of samples through use of a chain-of-custody record. This procedure will be followed for all samples collected or split samples accepted.

Field Custody

1. Collect only the number of samples needed to represent the media being sampled. To the extent possible, determine the quantity and types of samples and sample locations before the actual fieldwork. As few people as possible shall handle samples.

2. Complete sample labels or tags for each sample using waterproof ink.

3. Maintain personal custody of the samples (in your possession) at all times until custody is transferred for sample shipment or directly to the analytical laboratory.

Transfer of Custody and Shipment

1. Complete a chain-of-custody record for all samples (see Figure 1 for an example of a chain-of-custody record. Similar forms may be used when requested by the client). When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the sample custodian in the appropriate laboratory.

   - The date/time will be the same for both signatures when custody is transferred directly to another person. When samples are shipped via common carrier (e.g., Federal Express), the date/time will not be the same for both signatures. Common carriers are not required to sign the chain-of-custody record.

   - In all cases, it must be readily apparent that the person who received custody is the same person who relinquished custody to the next custodian.

   - If samples are left unattended or a person refuses to sign, this must be documented and explained on the chain-of-custody record.

Note: If a field sample custodian has been designated, he/she may initiate the chain-of-custody record, sign, and date as the relinquisher. The individual sampler(s) must sign in the appropriate block, but does (do) not need to sign and date as a relinquisher (refer to Figure 1).

2. Package samples properly for shipment and dispatch to the appropriate laboratory for analysis. Each shipment must be accompanied by a separate chain-of-custody record. If a shipment consists of multiple coolers, a chain-of-custody record shall be filled out for each cooler documenting only samples contained in that particular cooler.

3. The original record will accompany the shipment, and the copies will be retained by the FTL and, if applicable, distributed to the appropriate sample coordinators. Freight bills will also be retained by the FTL as part of the permanent documentation. The shipping number from the freight bill shall be recorded on the applicable chain-of-custody record and field logbook in accordance with TSOP 4-1, *Field Logbook Content and Control.*

Procedure for Completing CDM Example Chain-of-Custody Record
The following procedure is to be used to fill out the CDM chain-of-custody record. The record provided herein (Figure 1) is an example chain-of-custody record. If another type of custody record (i.e., provided by the EPA Contract Laboratory Program (CLP) or a subcontract laboratory or generated by FORMS II Lite™) is used to track the custody of samples, the custody record shall be filled out in its entirety.

1. Record project number.
2. Record FTL for the project (if a field sample custodian has been designated, also record this name in the "Remarks" box).
3. Record the name and address of the laboratory to which samples are being shipped.
4. Enter the project name/location or code number.
5. Record overnight courier's airbill number.
6. Record sample location number.
7. Record sample number.
8. Note preservatives added to the sample.
9. Note media type (matrix) of the sample.
10. Note sample type (grab or composite).
11. Enter date of sample collection.
12. Enter time of sample collection in military time.
13. When required by the client, enter the names or initials of the samplers next to the sample location number of the sample they collected.
14. List parameters for analysis and the number of containers submitted for each analysis.
15. Enter appropriate designation for laboratory quality control (e.g., matrix spike/matrix spike duplicate [MS/MSD], matrix spike/duplicate [MS/D]), or other remarks (e.g., sample depth).
16. Sign the chain-of-custody record(s) in the space provided. All samplers must sign each record.
17. If sample tags are used, record the sample tag number in the "Remarks" column.
18. The originator checks information entered in Items 1 through 16 and then signs the top left "Relinquished by" box, prints his/her name, and enters the current date and time (military).
19. Send the top two copies (usually white and yellow) with the samples to the laboratory; retain the third copy (usually pink) for the project files. Retain additional copies for the project file or distribute as required to the appropriate sample coordinators.
20. The laboratory sample custodian receiving the sample shipment checks the sample label information against the chain-of-custody record. Sample condition is checked and anything unusual is noted under "Remarks" on the chain-of-custody record. The laboratory custodian receiving custody signs in the adjacent "Received by" box and keeps the copy. The white copy is returned to CDM.

5.2 Sample Labels and Tags
Unless the client directs otherwise, sample labels or tags will be used for all samples collected or accepted for CDM projects.

1. Complete one label or tag with the information required by the client for each sample container collected. A typical label or tag would be completed as follows (see Figure 2 for example of sample tag; labels are completed with the equivalent information):

   - Record the project code (i.e., project or task number).
   - Enter the station number (sample number or EPA CLP identification number) if applicable.
   - Record the date to indicate the month, day, and year of sample collection.
   - Enter the time (military) of sample collection.

- Place a check to indicate composite or grab sample.
- Record the station (sample) location.
- Sign in the space provided.
- Place a check next to "yes" or "no" to indicate if a preservative was added.
- Place a check under "Analyses" next to the parameters for which the sample is to be analyzed. If the desired analysis is not listed, write it in the empty slot. Note: Do not write in the box for "laboratory sample number."
- Place or write additional relevant information under "Remarks."

2. Place adhesive labels directly on the sample containers. Place clear tape over the label to protect from moisture.

3. Securely attach sample tags to the sample bottle. On 2.27 liter (80 oz.) amber bottles, the tag string may be looped through the ring-style handle and tied. On all other containers, it is recommended that the string be looped around the neck of the bottle, then twisted, and relooped around the neck until the slack in the string is removed.

4. Double-check that the information recorded on the sample tag is consistent with the information recorded on the chain-of-custody record.

5.3 Custody Seals

Two custody seals must be placed on opposite corners of all shipping containers (e.g., cooler) before shipment. The seals shall be signed and dated by the shipper.

Custody seals may also be required to be placed on individual sample bottles. Check with the client or refer to EPA regional guidelines for direction.

5.4 Sample Shipping

CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples* defines the requirements for packaging and shipping environmental samples.

6.0 Restrictions/Limitations

Check with the EPA region or client for specific guidelines. If no specific guidelines are identified, this procedure shall be followed.

For EPA CLP sampling events, combined chain-of-custody/traffic report forms generated with EPA FORMS II Lite™ or other EPA-specific records may be used. Refer to regional guidelines for completing these forms.

The EPA FORMS II Lite™ software may be used to customize sample labels and custody records when directed by the client or the CDM project manager.

7.0 References

U. S. Army Corps of Engineers. 2001. *Requirements for the Preparation of Sampling and Analysis Plan*, EM 200-1-3. Appendix F. February.

U. S. Environmental Protection Agency. Revised March 1992. *National Enforcement Investigations Center, Multi-Media Investigation Manual*, EPA-330/9-89-003-R. p.85.

__________. Region IV. 1996. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. Section 3.3. May.

__________. 2002. *FORMS II Lite™ User's Guide, Version 5.1.*

__________. 2002. *EPA Guidance for Quality Assurance Project Plans*, EPA QA/G-5, EPA/240/R-02/009. Section 2.2.3. December.

__________. 2004. *Contract Laboratory Program (CLP), Guidance for Field Samplers,* EPA-540-R-00-003. Final. Section 3.2. August.

Figure 1
Example CDM Chain-of-Custody Record

CDM

125 Maiden Lane, 5th Floor
New York, NY 10038
(212) 785-9123
Fax: (212) 785-5114

CHAIN OF CUSTODY RECORD

PROJECT ID.	FIELD TEAM LEADER	LABORATORY AND ADDRESS	DATE SHIPPED
PROJECT NAME/LOCATION		LAB CONTRACT:	AIRBILL NO.

MEDIA TYPE
1. Surface Water
2. Groundwater
3. Leachate
4. Field QC
5. Soil/Sediment
6. Oil
7. Waste
8. Other ____________

PRESERVATIVES
1. HCl, pH <2
2. HNO3, pH <2
3. NaOH, pH >12
4. H2SO4, pH <2
5. Zinc Acetate, pH >9
6. Ice Only
7. Not Preserved
8. Other ____________

SAMPLE TYPE
G = Grab
C = Composite

SAMPLE LOCATION NO.	LABORATORY SAMPLE NUMBER	PRESERVATIVES ADDED	MEDIA TYPE	SAMPLE TYPE	20__ DATE	TIME SAMPLED	ANALYSES (List no. of containers submitted)								REMARKS (Note if MS/MSD)
1.															
2.															
3.															
4.															
5.															
6.															
7.															
8.															
9.															
10.															

SAMPLER SIGNATURES:

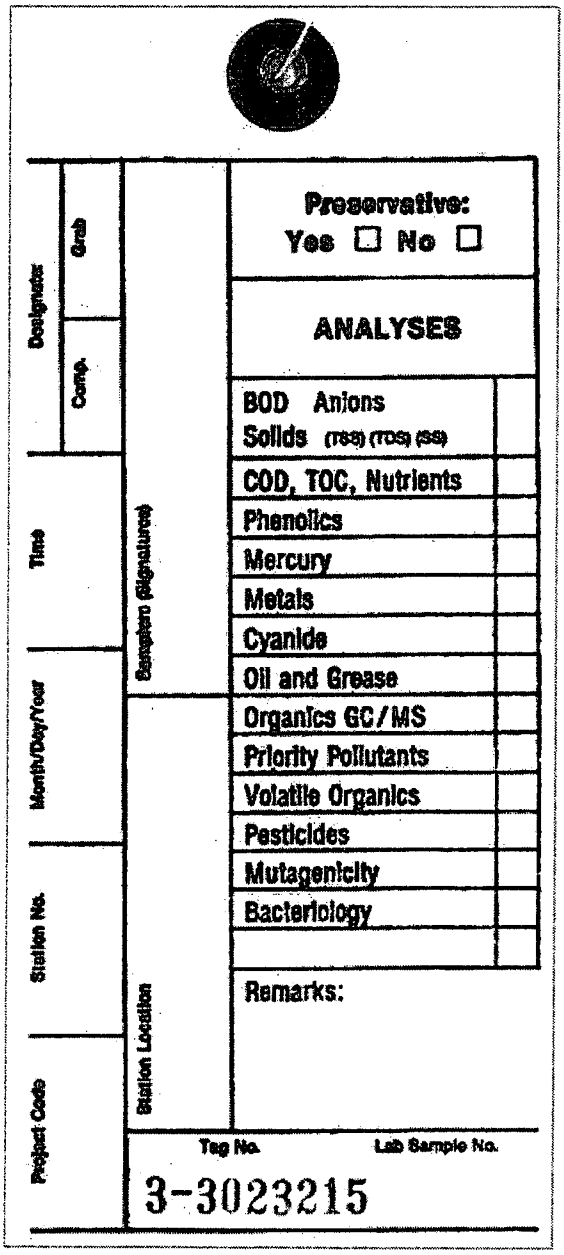
RELINQUISHED BY: (PRINT)	DATE/TIME	RECEIVED BY: (PRINT)	DATE/TIME	RELINQUISHED BY: (PRINT)	DATE/TIME	RECEIVED BY: (PRINT)	DATE/TIME
(SIGN)		(SIGN)		(SIGN)		(SIGN)	
RELINQUISHED BY: (PRINT)	DATE/TIME	RECEIVED BY: (PRINT)	DATE/TIME	RELINQUISHED BY: (PRINT)	DATE/TIME	RECEIVED BY: (PRINT)	DATE/TIME
(SIGN)		(SIGN)		(SIGN)		(SIGN)	

COMMENTS:

DISTRIBUTION: White and yellow copies accompany sample shipment to laboratory; yellow copy retained by laboratory. Pink copy retained by samplers. 1/98

Note: If requested by the client, different chain-of-custody records may be used. Copies of the template for this record may be obtained from the Chantilly Graphics Department.

Figure 2
Example Sample Tag



Designate: Grab / Comp.
Time
Month/Day/Year
Station No.
Project Code
Samplers (Signature)
Station Location

Preservative:
Yes ☐ No ☐

ANALYSES

BOD Anions
Solids (TSS) (TDS) (SS)
COD, TOC, Nutrients
Phenolics
Mercury
Metals
Cyanide
Oil and Grease
Organics GC/MS
Priority Pollutants
Volatile Organics
Pesticides
Mutagenicity
Bacteriology

Remarks:

Tag No. Lab Sample No.
3-3023215

Note: Equivalent sample labels or tags may be used.

TSOP 1-4

SUBSURFACE SOIL SAMPLING

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 1 - 4
Revision: 5
Date: October 13, 2004

SOP Title: **SUBSURFACE SOIL SAMPLING**

QA Review: J Orford

Approved and Issued: J Fitzwater
Program Manager Signature/Date

Contract No.: RAC II   Client: EPA Region II

Reason for Clarification: Include 1) sample collection procedures for VOCs using 40-ml closed-system vials and 2) soil homogenization procedure.

2.1 Definitions, add (on page 1 of 21):

Homogenization - The process of mixing individual grab samples in order to minimize the bias in sample representativeness introduced by the natural stratification of constituents within the sample. Homogenization of soil is accomplished by thoroughly mixing the collected soil with a stainless steel spoon or spatula in the following manner. The soil should be scraped from the stainless steel container sides, corners, and bottom, then rolled into the middle and initially mixed. The soil is then quartered and moved to the four quarters of the container. Each quarter of the sample should be mixed individually, then rolled to the center of the stainless steel container sample mixed again.

For the definition of Liner add:

Only stainless steel or Teflon® liners are to be used when sampling soil.

Add a Section 5.2.5.4 (page 11) to add an option for closed system vials:

5.2.5.4 Soil Sample Collection for Volatile Organic Compound (VOC) Analysis in Closed-System Vials
This procedure follows EPA's *CLP Sample Collection Guidelines for Volatile Organic Analytes (VOAs) in Soil by SW-846 Method 5035A*, May 2004, Option 1 (Appendix B of EPA's *Contract Laboratory Guidance for Field Samplers*).

Required Equipment
In addition to required equipment listed in Section 4.0, the following equipment is also needed:

- Tared or pre-weighed, pre-labeled 40 milliliter (mL) volatile organic analysis (VOA) vials containing a magnetic spin bar (three per sample)
- 60-mL glass jar with Teflon sealed cap or one 40-mL VOA vial
- Sample labels
- Portable scale
- Stainless steel spatula

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 1 - 4
Revision: 5
Date: October 13, 2004

SOP Title: **SUBSURFACE SOIL SAMPLING**

Method for Collecting Subsurface Soil Samples for Volatile Organic Compound (VOC) Analysis in Closed-System Vials

1. Use the appropriate decontaminated stainless steel or Teflon sampling device to collect the sample.
2. Open the split-spoon, core liner, or other subsurface soil sampler.
3. Complete the sample label by filling in the appropriate information. ***Do not*** cover the label with tape.
4. Place the tared or pre-weighed, pre-labeled 40-mL VOA vial and cap on the scale.
5. With the aid of a clean stainless steel spatula, quickly add 5 grams of soil to the vial.
6. Immediately secure the Teflon-lined cap on the sample container.
7. Repeat the procedure for the remaining two vials.
8. Collect percent moisture sample in a 40-mL VOA vial or 60-mL jar with Teflon sealed cap. Fill the entire sample container with soil, no headspace.
9. Store samplers at 4^0 Celsius, and ship the sample to the analytical laboratory. The sample must be received by the laboratory within 48 hours of sample collection.

7.0 Reference

U.S. Environmental Protection Agency. 2004. *Contract Laboratory Program (CLP) Guidance for Field Samplers,* Final. EPA-540-R-00-003, August.

________. 1989. Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual.* Final Copy. Revision 1. October.

Subsurface Soil Sampling

SOP 1-4
Revision: 6
Date: March 2007

Prepared: Del R. Baird **Technical Review:** Mark Caldwell

E-Signed by Michael C. Malloy
VERIFY authenticity with ApproveIt

QA Review: Jo Nell Mullins **Approved:**

E-Signed by P. Michael Schwan
VERIFY authenticity with ApproveIt

Issued:

Signature/Date *Signature/Date*

1.0 Objective

The objective of this standard operating procedure (SOP) is to define the techniques and requirements for collecting soil samples from the unconsolidated zone. Techniques include use of hand augers, split-barrel samplers, Shelby tubes, direct-push rig samplers, and backhoes.

2.0 Background

2.1 Definitions

Auger Flight - A steel section length attached to the auger length to extend the augers and remove additional unconsolidated material as drilling depth increases.

Backhoe - An excavator whose shovel bucket is attached to a hinged boom and is drawn backward to move earth.

Direct Push Rig Sampler - A sampler with a locking tip that keeps the device closed during the sampling push. The tip is released at the desired depth, and the push is continued. During the push, the soil moves into the sampler.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Hand Auger - A stainless steel cylinder (bucket) approximately 7 to 10 centimeters (cm) (3 to 4 inches) in diameter and 30 cm (1 foot) in length, open at both ends with the bottom edge designed to twist into the unconsolidated material and obtain a soil core. The auger has a T-shaped handle (used for manual operation) attached to the top of the bucket by extendable stainless steel rods.

Liner - A cylindrical sleeve generally made of brass, stainless steel, or Teflon® that is placed inside a split-barrel sampler, direct-push rig sampler, or hand auger bucket to collect samples for VOC analysis or prevent cross-contamination of the sample.

Shelby Tube - A cylindrical sampling device, generally made of steel, that is driven into the subsurface soil through a hollow-stem auger using a drill rig. The tube, once retrieved, may be capped and the undisturbed soil sample extruded in the laboratory before analysis.

Slide Hammer - A device consisting of a drive weight (hammer) and a drive weight fall guide.

Split-Barrel Sampler - A cylindrical sampling device generally made of carbon steel that fits into a hollow-stem auger. The sampler is opened lengthwise, which allows the sample to be retrieved by "splitting" the barrel sampler. Also referred to as a split-spoon.

Subsurface Soil - The unconsolidated material that exists deeper than approximately 30 cm (1 foot) below the ground surface.

Unconsolidated Zone - A layer of nonlithified earth material (soil) that has no mineral cement or matrix binding its grains.

2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 3-5, *Lithologic Logging*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

Shallow subsurface soil samples (to depths between 0.15 cm to 3 meters (m) [6 inches and 10 feet]) may be collected using hand augers. However, soil samples collected with a hand auger are commonly of poorer quality than those collected by split-barrel or Shelby tube samplers because the soil sample is disturbed in the augering process. Split-barrel and Shelby tube samplers are generally used during collection of soil samples using hollow-stem auger drill methods. Barrel-type samplers may also be used to collect soil samples from hand auger borings using a slide hammer device. Liners are used to minimize the loss of volatile organic compounds (VOCs) and to prevent cross-contamination from the sampler to the sample. The size and material of sampling devices shall be selected based on project and analytical objectives and defined in site-specific plans. Collecting samples using backhoes enables the collector to correlate the precise vertical and horizontal interval with adjacent materials (cross section).

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and the required equipment, and for ensuring that subsurface soil samples are collected in accordance with this procedure and any other SOPs pertaining to specific media sampling. The site manager must also ensure that the quantity and location of subsurface soil samples collected meet the requirements of the site-specific plans.

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect subsurface soil samples in accordance with this SOP and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

4.0 Required Equipment

4.1 General

- Site-specific plans
- Field logbook
- Indelible black ink pens and markers
- Clear, waterproof tape
- Labels and appropriate forms/documentation for sample shipment
- Appropriate sample containers
- Insulated cooler(s) and waterproof sealing tape
- Ice bags or "blue ice"
- Latex or appropriate gloves
- Plastic zip-top bags
- Personal protective clothing and equipment
- Plastic sheeting
- Stainless steel and/or Teflon-lined spatulas and pans, trays, bowls, trowels, or spoons
- Decontamination supplies
- Sample chain-of-custody forms
- Custody seals

Additional equipment is discussed in Section 5.2.7, Field Sampling/Preservation Methods.

4.2 Manual (Hand) Augering

- T-handle
- Hand auger: flighted-, bucket-, or tube-type auger as required by the site-specific plans
- Extension rods
- Wrench(es), pliers
- Slide hammer with extension rods

4.3 Split-Barrel and Shelby Tube Sampling
- Drill rig equipped with a 63-kilogram (kg) (140-lb) drop hammer and sufficient hollow-stem auger flights to drill to the depths required by the site-specific plans.
- Sufficient numbers of split-barrel samplers so that at least one is always decontaminated and available for sampling. Three split-barrel samplers are generally the minimum necessary (Shelby tubes are used only once).
- Split-barrel liners (as appropriate).
- Wrench(es), hammer.

4.4 Direct Push Rig Sampling
- Direct push rig with sufficient probe rods to extend to sample depths required by the site-specific plans
- Sufficient number of samplers (in case of malfunction) and appropriate liners to collect adequate number of samples
- Extension rods
- Wrench(es), pliers, other specific tools

4.5 Backhoe Sampling
- Backhoe with a sufficient length boom to extend to planned depths
- Sufficient number of trowels or scoops
- Extension rods
- Tape, utility knife, other specific tools as needed

5.0 Procedures
5.1 Preparation
1. Review site-specific health and safety plan and project plans before initiating sampling activity.

2. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

3. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook. When possible, reference locations back to existing site features such as buildings, roads, intersections, etc.

4. Processes for verifying depth of sampling must be specified in the site-specific plans.

5. Clear away vegetation and debris from the ground surface at the boring location.

6. Prepare an area next to the sample collection location for laying out cuttings by placing plastic sheeting on the ground to cover the immediate area surrounding the borehole.

7. Set up a decontamination line, if decontamination is required, in accordance with CDM Federal SOP 4-5.

5.2 Collection
The following general steps must be followed when collecting all subsurface soil samples:

1. Wear clean gloves during handling of all sample containers and sampling devices.

2. VOC samples or samples that may be degraded by aeration shall be collected first and with the least disturbance possible.

3. Sampling information shall be recorded in the field logbook and on any associated forms. Describe lithology, according to CDM Federal SOP 3-5, in the field logbook or on the lithologic log form.

4. Specific sampling devices to be used shall be identified in the site-specific plans and recorded in the field logbook.

5. Care must be taken to prevent cross-contamination and misidentification of samples.

6. Sample containers containing samples for VOC analysis shall be filled completely to minimize headspace.

5.2.1 Manual (Hand) Augering
The following steps must be followed when collecting hand-augered samples:

1. Auger to the depth required for sampling. Place cuttings on plastic sheeting or as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.

2. Throughout the augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.

3. Cease augering when the top of the specified sampling depth has been reached. If required, remove the auger from the hole and decontaminate the auger or use a separate decontaminated auger, then obtain the sample.

4. Collect a grab sample for VOC analyses (or samples that may be degraded by aeration) immediately and place in sample container. Sample bottles shall be filled completely to minimize headspace.

5. Remaining sample shall be homogenized for other analyses before placing samples in the appropriate containers. Label containers as required.

6. Wipe containers with a clean Kimwipe or paper towel to remove residual soil from the exterior of the container(s).

7. Label the sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.

8. Place the containers in zip-top plastic bags and seal the bags. Pack samples in a cooler with ice.

9. Proceed with further sampling, as required by the site-specific plans.

10. When all sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

11. Complete the field logbook entry and other appropriate forms, being sure to record all relevant information before leaving the site.

12. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.2 Manual (Hand) Augering Using a Tube Sampler with Liner or Slide Hammer
The following steps must be followed when collecting hand-augered samples using a tube sampler with liner or slide hammer:

1. Auger to the depth required for sampling. Place cuttings on the plastic sheeting as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.

2. Throughout augering, make detailed notes in the field logbook concerning the geologic features of the soil or sediments.

3. Cease augering when the top of the specified sampling depth has been reached. Remove the auger from the hole and decontaminate.

4. Prepare a decontaminated tube sampler by installing a decontaminated liner in the auger tube.

5. Obtain the sample by driving the sample tube through the sample interval with the slide hammer. Remove the liner from the tube and immediately cover the ends with Teflon tape and cap the ends of the tube. Seal the caps with waterproof tape.

6. Wipe sealed liners with a clean Kimwipe or paper towel.

7. Label the sealed liners as required in the site-specific plans. Mark the top and bottom of the sample on the outside of the liner.

8. Place sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.

9. Proceed with further sampling, as required by the site-specific plans.

10. When sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

11. Decontaminate all equipment according to CDM Federal SOP 4-5 between each sample.

12. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.

13. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.3 Split-Barrel Sampling
Note: Steps 1 through 12 describe activities to be performed by a licensed drilling contractor, not CDM personnel.

The following steps must be followed when collecting split-barrel samples:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.

2. The drilling rig will be decontaminated at a separate location before drilling, per CDM Federal SOP 4-5 or the site-specific decontamination procedures.

3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s) to the drill rig.

4. Begin drilling and proceed to the first designated sample depth, adding auger flights as necessary.

5. Upon reaching the designated sample depth, slightly raise the auger(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.

6. Remove the plug and center rods, if applicable.

7. If required by the site-specific sampling plan, install decontaminated liners in the split barrel sampler.

8. Install a decontaminated split-barrel on the center rod(s) and insert it into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.

9. Mark the center rod in 15-cm (6-inch) increments from the top of the auger(s).

10. Drive the split-barrel using the hammer. Use a full 76-cm (30-inch) drop as specified by the American Society for Testing and Materials (ASTM) Method D-1586. Record the number of blows required to drive the sampler through each 15-cm (6-inch) increment.

11. Cease driving when the full length of the spoon has been driven or upon refusal. Refusal occurs when little or no progress is made for 50 blows of the hammer. ASTM D1586-99 § 7.2.1 and 7.2.2 defines "refusal" as >50 blows per 6-inch advance or a total of 100 blows.

12. Pull the sampler free by using upswings of the hammer to loosen the sampler. Pull out the center rod and sampler.

13. Unscrew the sampler assembly from the center rod and place it on the plastic sheeting.

14. Remove the drive shoe and head assembly. If necessary, tap the sampler assembly with a hammer to loosen threaded couplings.

15. With the drive shoe and head assembly off, open (split) the sampler, being careful not to disturb the sample.

16. Label sample containers with appropriate information. Secure the label, covering it with a piece of clear tape. If liners were used, immediately install Teflon tape over the ends of the liners, cap the liners, and seal the caps over the ends of the liner with waterproof tape. Label the samples as required by the site-specific plans. Mark the top and bottom of each sample on the outside of each liner. Indicate boring/well number and depth on the outside of the liner, as required.

17. If VOC analyses are to be conducted on the soil sample and liners were not used, place that sample in its sample container immediately after opening the split-barrel, filling the sample bottle completely. Seal the container immediately, then describe it in the field logbook and/or associated forms. Record the sample identification number, depth from which the sample was taken, and the analyses to be performed on the samples in the field logbook and on the appropriate forms.

18. Remaining sample shall be homogenized before placing samples in appropriate containers.

19. Wipe containers with a clean Kimwipe or paper towel. Label containers as required when liners are not used.

20. Place containers and/or sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.

21. In the field logbook and on the boring log, describe sample lithology by observing cuttings and/or the bottom end of the liner.

22. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.

23. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.

24. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans. Backfill borehole as specified in project-specific plans.

25. Decontaminate samplers and other small sampling equipment according to CDM Federal SOP 4-5 before proceeding to other sampling locations.

26. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.

27. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.4 Shelby Tube Sampling
Note: Steps 1 through 11 describe activities to be performed by a licensed drilling contractor, not CDM personnel. ASTM D1586-99 provides more details pertaining to this sampling methodology.

The following steps must be followed when collecting samples using the Shelby tube:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.

2. The drilling rig will be decontaminated at a separate location before drilling.

3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s).
4. Begin drilling and proceed to the first designated sample depth, adding auger(s) as necessary.
5. Upon reaching the designated sample depth, slightly raise the auger(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods, if applicable.
7. Attach a head assembly to a decontaminated Shelby tube. Attach the Shelby tube assembly to the center rods.
8. Lower the Shelby tube and center rods into the hollow-stem augers and seat it at the bottom. Be sure to leave 30 inches or more of center rod above the lowest point to the hydraulic piston's extension.
9. Use the rig's hydraulic drive to push the Shelby tube into undisturbed soil. The tube shall be pushed with a slow, steady force. Note the pressure used to push the Shelby tube in the field logbook.
10. When the Shelby tube has been advanced to its full length or to refusal, back off the hydraulic pistons. Attach a hoisting plug to the upper end of the center rod, slightly twist to break off the sample, and pull the apparatus out of the hole with the rig winch.
11. Retrieve the Shelby tube to the surface, detach it from the center rod, and remove the head assembly.
12. Since the typical intent of Shelby tube sampling is for engineering purposes and an undisturbed sample is required, the tube ends shall be sealed immediately. Sealing is accomplished by filling any void space in the tube with melted beeswax, then placing caps on the ends of the tube and taping caps into place. The top and bottom ends of the tube shall be marked and the tube transported to the laboratory in an upright position. ***It is extremely important that the Shelby tube samples are not disturbed in any way (dropped, rolled, subjected to extreme temperatures, etc.)***.
13. Wipe sealed tubes with a clean Kimwipe or paper towel.
14. Indicate boring/well number and depth on outside of the tube.
15. Place sealed tubes in zip-top plastic bags, seal bags, and pack samples in a chilled cooler, if applicable.
16. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.
17. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.
18. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.
19. Complete the field logbook entry, being sure to record all relevant information before leaving the site. These methods may be used if directed by the EPA region, client, or governing sample plan.

5.2.5 Direct Push Rig Sampling

Note: Steps 1 through 11 describe activities to be performed by a licensed drilling contractor, not CDM personnel.

The following steps must be followed when collecting samples using a direct push rig sampler:

1. Verify that the push rig has been decontaminated at a separate location before drilling.
2. Attach the properly assembled sampler with appropriate liner to the end of the probe rod.

3. Attach drive cap and probe to the first designated sample depth, adding rod(s) as necessary.
4. Upon reaching the designated sample depth, remove the drive cap to access the inside of the probe rods.
5. Insert extension rods into probe rod; turn extension rod to release tip.
6. Retrieve extension rods, replace drive cap, add additional push rod if required, and push probe rod to the planned sample interval.
7. Attach pull cap and retrieve push rods and sampler.
8. Remove the sampler from the probe rod, then remove the cutting shoe from the sampler.
9. Once the cutting shoe is removed, the liner, containing the sample, can be removed from the sampler. The sample can now be handled per site-specific plans.
10. When sample collection is complete, remove the push rig to the heavy equipment decontamination area.
11. Dispose of excess sample cuttings, plastic sheeting, etc., as specified in the site-specific plans.
12. Complete the field logbook entry, being sure to record all relevant information before leaving the site. These methods may be used if directed by the EPA region, client, or governing sample plan.

5.2.6 Backhoe Sampling

Note: Steps 1, 2, 7, and 8 describe activities to be performed by a licensed heavy equipment operator, not CDM personnel.

The following steps must be followed when collecting samples using a backhoe:

1. Verify that the backhoe has been decontaminated at a separate location before excavation.
2. Excavate to the depth required.
3. Use a stainless steel trowel or scoop.
4. Attach the trowel to an electrical conduit, steel rod, or other similar devise.
5. Remove the surface layer of soil "smeared" on the trench wall.
6. Replace the trowel with a clean trowel and collect the sample.
7. When sample collection is complete in the trench, backfill the trench with the excavated material, if allowed.
8. Once the trench has been backfilled, move the backhoe to the heavy equipment decontamination area.
9. Dispose of excess sample cuttings, plastic sheeting, etc., as specified in the site-specific plans.
10. Complete the field logbook entry, being sure to record all relevant information before leaving the site. These methods may be used if directed by the EPA region, client, or governing sample plan.

5.2.7 Field Sampling/Preservation Methods

The following three sections contain SW 846 Methods for sampling and field preservation. These methods include EnCore™ Sampler Method for low-level detection limits, EnCore Sampler Method for high-level limits/screening, and methanol preservation. These methods may be used if required by the EPA Region, client, or governing sample plan. These methods are very detailed and contain equipment requirements at the beginning of each section.

When collecting soil samples using the EnCore Sampler Method, collection of soil for moisture content analysis is required. Results of this analysis are used to adjust "wet" concentration results to "dry" concentrations to meet analytical method requirements.

Note: Some variations from these methods, (e.g., sample volume) may be required depending on the contracted analytical laboratory.

5.2.7.1 EnCore Sampler Equipment and Collection Requirements for Low-Level Analyses (<200 µg/kg)
The following equipment is required for low-level analysis:

- Three 5 grams (g) samplers

Note: The sample volume requirements specified are general requirements. Actual sample volume and/or container sizes may vary depending on client or laboratory requirements.

- One 110-milliliter (mL) (4-ounce [oz.]) wide-mouth glass jar or applicable container for moisture analysis
- One T-handle
- Paper towels

The requirements for collecting low level analysis by the EnCore Sampler Method are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.

2. Remove sampler and cap from package and attach T-handle to sampler body.

3. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full. The O-ring will be visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.

4. Extract sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.

5. Push cap on with a twisting motion to secure to the sampler body.

6. Rotate the sampler stem counterclockwise until stem locks in place to retain sample within the sampler body.

7. Fill out sample label and attach to sampler.

8. Repeat procedure for the remaining two samplers.

9. Collect moisture sample in 110-mL (4-oz.) wide-mouth jar using a clean stainless steel spoon or trowel.

10. Store samplers at 4 degrees (°) Celsius (C), ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.7.2 EnCore Sampler Equipment and Collection Requirements for High-Level Analyses (≥200 µg/kg)
The following equipment is required for high-level analysis:

- One 5-g sampler or one 25-g sampler (the sampler size used will be dependent on client and laboratory requirements
- One 110-mL (4-oz.) wide-mouth glass jar or applicable container specified for moisture analysis
- One T-handle
- Paper towels

The requirements for collecting high-level analysis by the EnCore Sampler Method are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Remove sample and cap from package and attach T-handle to sampler body.
3. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full. The O-ring will be visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.
4. Use clean paper toweling to quickly wipe the sampler head so that the cap can be tightly attached.
5. Push cap on with a twisting motion to attach cap.
6. Fill out a sample label and attach to sampler.
7. Rotate sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.
8. Collect moisture sample in 110-mL (4-oz.) wide-mouth jar or designated container using a clean stainless steel spoon or trowel.
9. Store samplers at 4°C, ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.7.3 Methanol Preservation Equipment and Sampling Requirements for High-Level Analyses (≥200 µg/kg)
The following equipment is required for methanol preservation sampling:

- One preweighed jar that contains methanol or a preweighed empty jar accompanied with a preweighed vial that contains methanol (laboratory grade)
- One dry weight cup
- Weighing balance that accurately weighs to 0.01 g (with accuracy of ±0.1 g)
- Set of balance weights used in daily balance calibration
- Latex gloves
- Paper towels
- Cutoff plastic syringe or other coring device to deliver 5 g or 25 g of soil

The requirements for sampling and preservation are as follows:

1. Wear clean gloves during all handling of preweighed vials.
2. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/collection below.
3. Quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil. The 5-g or 25-g size used is dependent on client and laboratory requirements.
4. Carefully wipe the exterior of the collection device with a clean paper towel.
5. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on the client or laboratory requirements.

6. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.

7. Using the paper toweling, remove any soil off of the vial threads and cap the jar.

8. Weigh the jar with the soil in it to the nearest 0.01 g and record the weight on the sample label.

9. Collect dry weight sample using a clean stainless steel spoon or trowel.

10. Store samples at 4°, ±2°C.

11. Ship sample containers with plenty of ice in accordance with DOT regulations (CORROSIVE. FLAMMABLE LIQUID. POISON) to the laboratory.

6.0 Restrictions/Limitations

Basket or spring retainers may be needed for split-barrel sampling in loose, sandy soils.

Shelby tubes may not retain the sample in loose, sandy soils.

7.0 References

American Society for Testing and Materials. 1999. *Standard Test Method for Penetration Test and Split Barrel Sampling of Soils*. Standard Method D1586-99.

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U. S. Department of Energy. 1996. Hazardous Waste Remedial Actions Program. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R2. September.

__________. Hazardous Waste Remedial Actions Program. *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R1. September 1996 or current revision.

U. S. Environmental Protection Agency. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, Third Edition, November 1986, (as amended by Updates I, II, IIA, IIB, III, and IIIA, June 1997). Method 5035 (***Note***: § 6.2.1.8 of this method says samples stored in EnCore™ samplers shall be analyzed within 48 hours or transferred to soil sample vials in the laboratory within 48 hours): December 1996, Revision O, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

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TSOP 1-6

WATER LEVEL MEASUREMENT

Water Level Measurement

SOP 1-6
Revision: 6
Date: March 2007

Prepared: Del Baird

Technical Review: Peggy Bloisa

E-Signed by Michael C. Malloy
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1.0 Objective

Water level measurements are fundamental to groundwater and solute transport studies and are conducted during groundwater sampling events to calculate the amount of groundwater to be purged from the well. This standard operating procedure (SOP) defines the techniques and requirements for obtaining groundwater level measurements.

2.0 Background

2.1 Definitions

Water Level Indicator - A portable device for measuring the depth from a fixed point (which could be below, at, or above the ground surface) to the groundwater inside a well, borehole, or other underground opening.

Measurement Point - An easily located and clearly defined mark at the top of a well from which all water level measurements from that particular well are made. The measurement point shall be as permanent as possible to provide consistency in measurements.

Electrical Tape - A graduated plastic tape onto which a water-sensitive electrode is connected that will electronically signal the presence of water (as a result of circuit closure).

Immiscible Fluids - Two or more fluid substances that will not mix and, therefore, will exist together in a layered form. The fluid with the highest density will exist as the bottom layer, the fluid with the lowest density will exist as the top layer, and any other fluid layers will be distributed relative to their respective densities.

Discharge - The removal/release of water from the zone of saturation.

Recharge - The addition of water to the zone of saturation.

Static Water Level - The level of water in a well, borehole, or other underground opening that is not influenced by discharge or recharge.

Well Riser - A steel, stainless steel, or polyvinyl chloride pipe that extends into a borehole and is connected to the well screen or sealed at the bedrock surface in open-hole wells. The upper portion (approximately 3 to 5 feet) of the well riser is normally enclosed by an outer steel protective casing.

Protective Casing - A steel cylinder or square protective sleeve extending approximately 3 to 5 feet into the ground, surrounding the well riser. In flush-mounted wells, the protective casing will extend only high enough so that the well and protective casing can be enclosed by a Christy box or equivalent vault. In above-grade wells, the protective casing will extend above the ground surface approximately 2 to 3 feet. The protective casing protects the well riser.

2.2 Associated Procedures

- CDM Federal (CDM) SOP 4-1, *Field Logbook Content and Control*
- CDM SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

The most common uses of static water level data are to determine the elevation of groundwater, the direction of groundwater flow, to identify areas of recharge and discharge, to evaluate the effects of manmade and natural stresses on the groundwater system, to define the hydraulic characteristics of aquifers, and to evaluate stream-aquifer relationships. Specific uses for water level data may include:

- Determine the change in water level due to distribution or rate of regional groundwater withdrawal
- Show the relationship of groundwater to surface water
- Estimate the amount, source, and area of recharge and discharge
- Determine rate and direction of groundwater movement

Static water level measurements shall be obtained from each well before purging, sampling, or other disturbance of the water table.

3.0 General Responsibilities

Project Manager - The project manager is responsible for ensuring that measurements are conducted in accordance with this procedure and any other SOP pertaining to site activities related to obtaining groundwater level measurements.

Field Team Leader - The field team leader is responsible for ensuring that field personnel obtain water level measurements in accordance with this and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

4.1 General

- Site-specific plans
- Field logbook
- Indelible black ink pens
- Permanent felt-tip marker (e.g., Sharpie)
- Personal protective equipment
- Decontamination equipment and supplies, including rinse bottles and deionized water
- Tap water and large beaker or bucket
- Water level meter

4.2 Measuring Devices

The equipment required to obtain water level measurements is dependent on the type of procedure chosen. Measurements may be made with a number of different devices and procedures. Measurements are taken relevant to a permanent measurement point on the well riser.

Electrical tapes are preferred over other devices such as steel tape because of the electrical tape's simplicity and ability to make measurements in a short period of time. Many types of electrical instruments have been devised for measuring water levels; most operate on the principle that a circuit is completed when two electrodes are immersed in water. Examples of electrical tapes that are frequently used include the Slope Indicator Co.® and Solinst® electronic water level indicators. These instruments are powered by batteries that shall be checked before mobilization to the field.

Electrical tapes are coiled on a hand-cranked reel unit that contains the batteries and a signaling device that indicates when the circuit is closed (i.e., when the probe reaches the water). Electrodes are generally contained in a weighted probe that keeps the tape taut in addition to providing some shielding of the electrodes against false indications as the probe is being lowered into the hole. The electrical tapes are marked with 0.01-foot increments. Caution shall be exercised when using electrical tapes when the water contains elevated amounts of dissolved solids. Under these conditions, the signaling device will remain activated after the probe is removed from the water. When the water being measured contains very low amounts of dissolved solids, it is possible for the probe to extend several inches below the water level before activating the signaling device. Both of these conditions are related to the conductivity of the water and in some cases may be compensated for by the sensitivity control, if the device has this option. In groundwater with high conductivity the sensitivity control may need to be turned down, and in groundwater with low conductivity the sensitivity control may need to be turned up to get a proper depth to groundwater measurement.

5.0 Procedures

5.1 Preparation

The following steps must be taken when preparing to obtain a water level measurement:

- Assign a designated field logbook to record all field events and measurements according to CDM SOP 4-1. Document any and all deviations from SOPs and site-specific plans in the logbook and include rationale for the changes.
- Always exercise caution to prevent inappropriate or contaminated materials from entering an environmental well.
- Standing upwind from the well, open the groundwater well. Monitor the well with a photoionization detector, flame ionization detector, or equivalent vapor analyzer as soon as the cap is opened, as dictated by the site-specific health and safety plan.

For comparability, water level measurements shall always be referenced to the same vertical (elevation) datum marker, such as a U. S. Geological Survey (USGS) vertical and horizontal control point monument. The elevations calculated from the measurement of static water levels shall be referenced to mean sea level unless otherwise specified in the site-specific plans.

The measurement point must be as permanent as possible, clearly defined, marked, and easily located. Frequently, the top of the PVC riser is designated as the measurement point. However, since the top of the riser is seldom smooth and horizontal, one particular point on the riser pipe shall be designated and clearly marked. This can be accomplished by marking a point on the top of the riser pipe with a permanent marker. To avoid spilling liquids into the well, paints or other liquid marking materials shall not be used.

5.2 Water Level Measurement Using Electrical Water Level Indicators

The following steps must be followed when taking water level measurements using electrical tapes:

- Before lowering the probe into the well, the circuitry shall be checked by dipping the probe in tap water and checking to ensure that the signaling device responds to probe submergence. The probe shall then be lowered slowly into the well until contact with the water surface is indicated. The electrical tape reading is made at the measuring point. Take a second and third check reading to verify the measurement before completely withdrawing the tape from the well.
- Independent electrical tape measurements of static water levels using the tape shall agree within 0.01 foot for depths of less than about 200 feet. At greater depths, independent measurements may not be this close. For a depth of about 500 feet, the maximum difference of independent measurement using the same tape shall be within 0.1 foot.
- Decontaminate the electrical tape according to CDM SOP 4-5 before proceeding to the next well to minimize cross contamination.

It may be necessary to check the electrical tape length with a graduated steel tape after the line has been used for a long period of time (at least annually) or after it has been pulled hard in attempting to free the line. Some electrical tapes, especially the single line wire, are subject to becoming permanently stretched.

5.3 Other Water Level Measurement Methods

Although the method cited above (electrical water level indicator) for measuring water levels predominates in the environmental sector, there are a number of other methods available that may be well suited for a particular purpose.

5.3.1 Ultrasonic Method

The ultrasonic method electronically measures the amount of time it takes a sound wave to reach and reflect off the water surface and return to the ground surface. These instruments contain electronic microprocessors, capable of performing this measurement many times each second. The actual depth to water, as calculated by the microprocessor, is an average of many individual readings.

5.3.2 Pressure Gauge Method

This method, also called the air-line submergence method, uses a pressure gauge and is the preferred method for obtaining water level measurements in pumping wells. An air line constructed of semi-rigid tubing is inserted into the well below the water table. The tube end at the surface is connected to an air tank or compressor and pressure gauge. Filtered air is then forced through the tube and the resultant pressure is read in pounds per square inch (psi). This reading is converted to feet of water in the column and subtracted from the total tube length to give depth to water. Readings are then converted to groundwater elevation. Results are plotted on a field logging form. Calibration records and the exact procedures used must be maintained.

5.3.3 Acoustic Probe Method

The acoustic probe is an electronic device containing two electrodes and a battery-powered transducer. The probe is attached to a tape. The probe is lowered into the well until a sound is detected, indicating the electrodes in the probe have contacted the water surface. This method is similar to the electrical probe method discussed in Section 5.2.

5.3.4 Continuous Recording Method

The measurement of groundwater elevations within pumping or monitoring wells can be accomplished by the use of a mechanical or digital analog computerized continuous recording system and shall be performed according to specifications given by the manufacturer of each unit. In general, when using the mechanical or digital system, the pressure or electrical transducer is lowered into the well until it intersects the water surface. The actual depth to water is then measured by one of the methods described above and used to calibrate the continuous recorder.

The necessary adjustments and preparations are then completed according to the specifications given for each type of continuous recorder. Proper maintenance of continuous recording devices during water level monitoring shall be performed such that continuous, permanent records are developed for the specified period of time. Records shall be stored on mechanical graph paper or on a microprocessor. Frequent calibrations of equipment shall also be made during monitoring periods of long duration in accordance with the manufacturers' specifications.

6.0 Restrictions/Limitations

6.1 Groundwater and Miscible Fluids

Where water is rapidly dripping or flowing into a well, either from the top of the well or from fractures, obtaining an accurate reading may not be possible.

The effect of the water flowing into the well may interfere with an electronic water level measuring device, resulting in a false water level measurement. If water levels must be recorded in wells completed in aquifers that are recharging or discharging, the electronic water level indicator is the preferred measuring device, but shall be used with the awareness of possible false measurements. To minimize the effects of "splashing," a 1-inch pipe (decontaminated for environmental wells) may be lowered into the pumping well into which the water level indicator would be inserted. This will minimize the effect of "splashing" until the probe contacts the groundwater and protect the probe from becoming tangled in pump wiring or well spacers associated with downhole equipment such as submersible pumps.

6.2 Immiscible Fluids

For wells containing immiscible contaminants, the field personnel will need to use special procedures for the measurement of fluid levels. The procedure to follow will depend on whether layers are light immiscibles that form lenses floating on the top of the water table, or dense immiscibles that sink through the aquifer and form lenses over less permeable layers.

In the case of light immiscibles, measurements of immiscible fluid and water levels cannot be accomplished by using normal techniques. A conventional electrical tape often will not respond to nonconducting immiscible fluids.

Techniques have been specially developed to measure fluid levels in wells containing immiscible fluids, particularly petroleum products. A special paste or gel applied to the end of the steel tape and submerged in the well will show the top of the oil as a wet line and the top of the water as a distinct color change, or an interface probe can be used that will detect the presence of conducting and nonconducting fluids. Thus, if a well is contaminated with low density, nonconducting immiscible fluids such as gasoline, the probe will first detect the surface of the gasoline, but it will not register electrical conduction. However, when the probe is lowered deeper to contact water, it will detect electrical conduction. Normally, a variation in an audible signal indicates the difference between phases.

Both of these methods have disadvantages. These methods are less effective with heavier and less refined petroleum products because the product tends to stick to the tape or probe, giving a greater product thickness measurement than it shall. Paste or gel cannot be used when sampling groundwater for the same constituents present in the paste or gel product.

Note that water levels obtained in this situation are not suitable for determining hydraulic gradients without further interpretation. To use such data for determining hydraulic gradients, the difference in density between the light immiscible phase and water has to be considered.

Measuring fluid levels in wells screened in lenses of dense immiscible fluids resting on a low permeability formation is somewhat easier, provided the immiscible fluid is nonconducting. The top of the dense layer can be identified by simply using an electrical sounder. As an electrical sounder passes from groundwater into the immiscible phase, the detection unit will deactivate because the fluid will no longer conduct electricity. A better method would be to use an interface probe as described above. The variation in the audible signal associated with the detection of differing phase liquids will also allow the user to obtain a groundwater depth and dense immiscible thickness measurement.

7.0 References

Camp Dresser & McKee Inc., et al. 1991. *Sampling and Analysis Procedures, Geophysical Survey Procedures*. May.

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TSOP 1-9

TAP WATER SAMPLING

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 1- 9
Revision: 2
Date: October 15, 2004

SOP Title: TAP WATER SAMPLING

QA Review: J Oxford

Approved and Issued: J Litwin 11/1/04
Program Manager Signature/Date

Contract No.: RAC II   Client: EPA Region II

Reason for Clarification: Make SOP EPA Region II - Specific

5.0 PROCEDURES, under Step 5 add:

When sampling, a tap must be free of any hose attachment, or water purification devices.

7.0 REFERENCES, add

U.S. Environmental Protection Agency, Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual*, Final Copy, Revision 1. October 1989.

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 1- 9
Revision: 1
Date: December 4, 2000

SOP Title: **TAP WATER SAMPLING**

QA Review: *[signature]*

Approved and Issued: *[signature]* for 12/6/00
Program Manager Signature/Date

Contract No.: RAC II Client: USEPA, Region II

Reason for and Clarification: Make SOP USEPA Region II - Specific.

Clarification (attach additional sheets if necessary; state section and page numbers when applicable):

5.0 PROCEDURES, under Steps 3, 6 and 11 add:

When sampling, a tap must be free of any aerator, strainer, hose attachment, or water purification devices.

7.0 REFERENCES, add

U.S. Environmental Protection Agency, Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual*, Final Copy, Revision 1. October 1989.

TAP WATER SAMPLING	SOP: 1-9 Revision: 1 Date: February 18, 1999 Page: 1 of 7

Prepared: James Pavlik

Technical Review: Tim Eggert

QA Review: David O. Johnson

Approved: [signature] 3/23/99
Signature/Date

Issued: [signature] 2/24/99
Signature/Date

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to define the requirements for collecting tap water samples for the purposes of assessing water quality. General guidelines for purging the water supply system prior to sample collection are also provided. Depending on the objective of the sampling event as defined in the site-specific sampling plan, the water source may be from a private or public, potable water supply, such as a groundwater well or a surface water reservoir.

2.0 BACKGROUND

2.1 Discussion

Tap water sampling may be conducted in residential, commercial, or industrial areas. Consequently, sampling personnel will interface with the general public (i.e., homeowners, business owners, or concerned citizens) and must present themselves in the utmost professional manner. Permission to access the property must be obtained prior to conducting the tap water sampling event; the client should be consulted as to the proper notification procedures. At the time of the sampling, it is recommended that a letter of introduction be presented to the property owner or representative, explaining the purpose of the tap water sampling and indicating the name of the person and phone number to contact if the property owner has questions. At no time should the sampling team enter a home or business without the approval of the property owner; the property owner or representative must be present in order to enter a building.

Generally, water supply sources and distribution systems can be categorized into two types:

- Onsite water supplies such as private, groundwater wells or surface water intakes for single residences, businesses, or industrial plants with limited distribution systems.

- Large distribution systems from public or municipal groundwater or surface water supplies with extensive distribution systems for multiple users.

The site-specific sampling plan should describe the source of the potable water supply, the water distribution system, and other site-specific factors which may affect the water quality (i.e., well construction details, local hydrogeology, the presence of filters or holding tanks within the distribution system, pipe age and composition, etc.). It is preferable to collect the samples from a tap located prior to a filtering device or a holding tank so that contaminants will be less likely to have been removed or allowed to settled out. The sampling objectives and sampling requirements, including analytical parameters, preservatives, and sample handling procedures must also be specified. Depending on the water source and distribution system, the site-specific sampling plan should describe the requirements for purging the system prior to collecting the tap water sample and for disposing of the purged water.

The procedures described in this SOP provide guidelines to obtain representative tap water samples from water supplies/distribution systems ranging from small, onsite water supplies to large, multi-user distribution systems.

2.2 Definitions

Holding Tank - An in-house, water reservoir that provides a limited reserve water supply and equalizes water pressure throughout the plumbing system. Most domestic well holding tanks have a storage capacity of approximately 30 gallons.

Onsite Water Supply - a source of potable water located on the property to be sampled. The water source could be a groundwater aquifer (i.e., a residential groundwater well) or a surface water body (i.e., a water intake from a lake).

Potable Water - water considered safe for human consumption.

Tap Water Samples - Samples of water collected from a faucet or spigot at a residence, business, or industrial plant. Usually, samples are collected from the tap(s) nearest the water supply source or area of interest along the distribution system.

Water Filter - A device used to remove suspended particulate matter and/or various compounds from the water source. One type of common filter is a water softener that uses a calcium-salt filter to remove calcium and magnesium ions from potable water to reduce the hardness.

2.3 Associated Procedures

- SOP 1-2, Sample Custody
- SOP 2-5, Packaging and Shipping of Environmental Samples

- SOP 4-1, Field Logbook Content and Control
- SOP 4-3, Well Development and Purging
- SOP 4-5, Field Equipment Decontamination

3.0 RESPONSIBILITIES

Field Team Leader (FTL) - The FTL is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any associated SOPs.

Sampling Personnel - Field team members are responsible for conducting tap water sampling events in accordance with this procedure, all associated SOPs, and requirements as described in the site-specific plans.

4.0 REQUIRED EQUIPMENT

- Site-specific plans including letter(s) of introduction
- Field logbook and indelible black ink pens and markers
- Forms and other documentation for sample shipment
- Sample containers, labels, and preservatives, as required
- Insulated cooler and waterproof sealing tape
- Ice bags or "blue ice"
- Plastic zip-top bags
- 5-gallon bucket and stop watch
- Temperature, conductivity, pH, dissolved oxygen, and turbidity meters (with clean beakers or other appropriate containers), as required by the site-specific plans
- Photoionization detector (PID) and/or other monitoring/screening instruments as required by the site-specific health and safety plan or sampling plan
- Decontamination supplies, as required by SOP 4-5
- Personal protective equipment (PPE), as required by the site-specific health and safety plan
- Latex or appropriate gloves

5.0 PROCEDURES

1. Obtain the name(s) of the resident(s) or water supply owner/operator, the exact mailing address, and telephone numbers. This information is required to obtain access to the property

to be sampled and to submit a letter of introduction to the owner/representative.

2. Determine the location of the tap to be sampled based on its proximity to the water source. The tap being sampled must be prior to any holding, or pressure tanks, filters, water softeners, or other treatment devices that may be present.

3. If the sample must be collected at a point in the water line beyond a pressurization or holding tank, a sufficient volume of water should be purged to provide a complete exchange of fresh water into the tank and at the location where the sample is collected. If the sample is collected from a tap or spigot located just before a storage tank, spigots located inside the building or structure should be turned on to prevent any backflow from the storage tank to the sample tap or spigot. It is generally advisable to open as many taps as possible during the purge, to ensure a rapid and complete exchange of water in the tanks.

4. Samples collected to determine if system related variable (e.g., transmission pipes, water coolers/heaters, holding/pressurization tanks, etc.) are contributing to the quality of potable water should be collected after a specific time interval (e.g., weekend, holiday, etc.). Sample collection should consist of an initial flush, a sample after several minutes, and another sample after the system has been purged.

5. Devices such as hoses, filters or aerators attached to the tap may harbor a bacterial population and therefore should be removed prior to sampling.

6. Sample containers should not be rinsed before use when sampling for bacterial content and precautions should be taken to avoid splashing drops of water from the ground or sink into either the bottle or cap.

7. Samples of the raw water supply and the treated water after chlorination should be collected when sampling at a water treatment plant.

8. In the logbook, record the location and describe the general condition of the tap selected for sampling. The rationale used in selecting the tap sampling location, including any discussions with the property owner, should also be recorded. Provide a sketch of the water supply/distribution system noting the location of any filters or holding tanks and the water supply source (i.e., an onsite groundwater well or surface water intake, or a water service line from a public water main). If an onsite water supply is present, observe and record the surrounding site features which may provide potential sources of contamination to the water supply.

9. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan. Latex gloves should be changed between sampling locations to avoid possible cross-contamination of the tap water samples.

10. Prior to sample collection, the supply system should be purged by turning the cold water tap on. The following general guidelines should be followed to determine when the system is adequately purged (refer to the site-specific sampling plans for any other requirements):

    - **Onsite Water Supply.** A minimum of 3 standing volumes of water (i.e., the static volume of water in the well and holding tank, if present) should be purged. Obtain water temperature, conductivity, and pH measurements after each volume of water is purged. If the standing volume of water in the supply system is unknown, the tap should be allowed to run for a minimum of 15 minutes and temperature, conductivity and pH measurements, or other parameters as specified by the project plan, should be collected at approximately 3- to 5-minute intervals. (In general, well construction details and holding tank volumes should be obtained prior to conducting the sampling event to estimate the standing volume of the water supply system.) The system is considered adequately purged when the temperature, conductivity, and pH stabilize within 10% for three consecutive readings. If these parameters do not stabilize within 15 minutes, then purging should be discontinued and tap water samples may be collected as discussed in #6.

    - **Large Distribution Systems.** Because it is impractical to purge the entire volume of standing water in a large distribution network, a tap should be run for a minimum of 5 minutes which should be adequate to purge the water service line. Obtain temperature, conductivity, and pH measurements at approximately 1-minute intervals. The system is considered adequately purged when the temperature, conductivity, and pH readings, or other parameters as specified by the project plan, stabilize within 10% for three consecutive readings. If these parameters do not stabilize within 5 minutes, then purging should be discontinued and tap water samples may be collected as discussed in #6.

    During purging, a 5-gallon bucket and stop watch may be used to estimate the flow rate if required by the site-specific plans. Dispose the purged water according to the site-specific plans. Record the temperature/conductivity/pH readings, or other parameters as specified by the project plan, the volume of water purged, the flow rate if measured, and the method of disposal in the field logbook.

11. After purging the supply system, collect the samples directly from the tap (i.e., if a hose was used for purging, the hose should be disconnected prior to sampling). Any fittings on the end of the

faucet that might introduce air into the sample (i.e., a fine mesh screen that is commonly screwed onto the faucet) should be removed prior to sample collection also.

12. Obtain a smooth-flowing water stream at moderate pressure with no splashing. Samples for volatile organic compound (VOC) analyses should be collected using a reduced flow rate (see below). Hold the sample bottle in one hand and the cap in the other; do not touch the inside of the cap; do not allow the faucet to touch the inside of the bottle; do not allow splashing water from the ground or sink to enter the bottle or cap. VOC samples should be filled first, followed by other organic analyses, inorganic analyses, and then other water quality parameters. Refer to the site-specific plans for the required sample parameters, preservatives, and sample handling procedures. The following general guidelines should be followed when collecting samples:

   - **VOC.** Reduce the flow rate to a minimum to reduce aeration of the VOC sample. Use a pre-preserved "test" vial to determine the appropriate amount of hydrochloric acid (HCl) needed to reduce the pH of the sample to less than 2. Dispose of this test vial after the appropriate amount of HCl is determined. Add the required amount of HCl to the sample vials and then fill the vials with the sample water. Quickly replace the cap and check for air bubbles. If air bubbles are present, the vial will be discarded and a new vial be filled as detailed above.

   - **Semivolatile Organic Compounds (SVOCs), Pesticides, and Polychlorinated Biphenyls (PCBs).** Generally, aqueous samples for SVOCs and pesticides/PCBs require no preservative. Sample containers may be filled directly from the tap.

   - **Total (unfiltered) Metals.** Generally, tap water samples are not collected for filtered (dissolved) metals because risk assessment data needs require total metals analyses (check the site-specific plans to determine filtering requirements). The sample container for total metals may be filled directly from the tap. Nitric acid (HNO_3) should then be added to the filled container to preserve the sample to a pH less than 2.

   - **Other Sample Parameters.** Other water quality parameters, such as cyanide dissolved oxygen, hardness, nitrate/nitrite, etc., should be collected and preserved as required by the site-specific sampling plans.

13. Label all sample containers as required and place them in a cooler with ice. Record all appropriate data in the field logbook and on the chain-of-custody forms.

6.0 RESTRICTIONS/LIMITATIONS

To protect the sample from contamination on the exterior of a tap, a tap should not be chosen for sampling if any of the following conditions exist:

- A leaky tap allowing water to flow out from around the stem of the valve handle and down the outside of the faucet.
- A tap located too close to the bottom of the sink or the ground surface.
- A tap that allows water to run up on the outside of the lip.
- A tap that does not deliver a steady stream of water. A temporary fluctuation in line pressure may cause sheets of microbial growth, lodged in some pipe sections or faucet connections, to break loose.

Careful sampling for VOC analysis, or for any other compound(s) that may be degraded by aeration, is necessary to minimize sample disturbance and, hence, analyte loss.

7.0 REFERENCES

U.S. Environmental Protection Agency, Region IV, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Section 8, Sampling of Potable Water Supplies, May 1996.

TSOP 1-10

FIELD MEASUREMENT OF ORGANIC VAPORS

Field Measurement of Organic Vapors

SOP 1-10
Revision: 4
Date: March 2007

Prepared: Tammy Phillips **Technical Review:** Chris Koerner

E-Signed by Michael C. Malloy
VERIFY authenticity with ApproveIt

QA Review: Jo Nell Mullins **Approved:**

Signature/Date

E-Signed by P. Michael Schwan
VERIFY authenticity with ApproveIt

Issued:

Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to define the techniques and the requirements for the measurement of organic vapors in the field.

2.0 Background

2.1 Definitions

Photoionization Detector (PID) - A portable, hand-held instrument that measures the concentration of gaseous organic compounds through the photoionization of organic vapors.

Flame Ionization Detector (FID) - A portable, hand-held instrument that measures the concentration of gaseous organic compounds through the flame ionization of organic vapors.

2.2 Associated Procedures

- CDM Federal SOP 1-4, *Subsurface Soil Sampling*
- CDM Federal SOP 1-5, *Groundwater Sampling Using Bailers*
- CDM Federal SOP 1-6, *Water Level Measurement*
- CDM Federal SOP 1-8, *Volatile Organic Compound Air Sampling Using USEPA Method TO-15 with SUMMA Canister*
- CDM Federal SOP 3-1, *Geoprobe® Sampling*
- CDM Federal SOP 3-5, *Lithologic Logging*
- CDM Federal SOP 4-3, *Well Development and Purging*

2.3 Discussion

The measurement of organic vapors is a required step during numerous field activities. The primary purpose of such measurements is health and safety monitoring to determine if the breathing zone in a work area is acceptable or if personal protective equipment such as a respirator or a supplied air device is necessary for field personnel. In addition to health and safety monitoring, organic vapor measurement is also used in conjunction with sampling activities, including screening subsurface soil samples, soil vapor and indoor air sampling, and groundwater sampling, where measurements are useful for establishing approximate contaminant levels or ranges.

The two types of instruments most commonly used to measure organic vapors are PIDs and FIDs. Both instruments first ionize the gaseous compound and then measure the response, which is proportional to the concentration.

2.3.1 PID Operation

The PID is preferred when the compound of interest is an aromatic or chlorinated volatile organic compound (VOC). The PID ionizes the sampled vapors using an ultraviolet lamp that emits light energy at a specific electron voltage (eV - labeled on the lamp). The ultraviolet lamp produces photons that are absorbed by the sampled vapor molecule. The molecule becomes excited, producing a positively charged ion and emitting an electron. The number of electrons emitted is proportional to the concentration of the sampled gases. Every organic compound has a specific ionization potential in electron volts. The energy emitted by the lamp must be higher than the ionization potential of the compound for the compound to become ionized and emit an electron. If the ionization potential of the compound is higher than the eV of the lamp, there will be no response on the instrument. Therefore, the ionization potential of the known or suspected compounds shall be checked against the energy of the ultraviolet lamp to verify that the energy provided by the lamp is greater. Additionally, manufacturer's manuals shall be consulted to obtain the appropriate correction factors for known or suspected contaminants.

Water vapor in the vapor sample can interfere with the PID detector and cause the instrument to stop responding. This can be caused by using the PID on a rainy day or when sampling headspace samples that have been in the sun. If moisture is suspected, the calibration gas shall be used to check the instrument response by inserting the gas as a check sample, not by recalibrating. If the response is lower than the gas level, then the probe and the ionization chamber shall be dried out before reusing the instrument.

Note: The ultraviolet lamp in the PID is sensitive to shock, especially when using the higher eV lamps. Therefore, they shall be handled and transported carefully.

The sampling probe shall not be inserted directly into soil samples or dusty areas, as the instrument vacuum will pull dirt into the ionization chamber. Under particularly dirty or dusty conditions, the lamp may become covered with a layer of dust. If dirty conditions are encountered, or if the instrument response seems to have decreased, then the lamp shall be cleaned. The instrument manual provides instructions on how to remove the instrument cover to access the lamp, and how to clean the screen in the ionization chamber and the surface of the lamp.

2.3.2 FID Operation

The FID is preferred when sampling for petroleum hydrocarbons and methane (landfill gases). It responds well to aromatic hydrocarbons but is not as convenient to use as the PID. The FID allows measurement of a wide variety of compounds, but in general its sensitivity is not as high as the PID for compounds where the PID is applicable.

The FID ionizes the vapor sample by burning it in a hydrogen/air flame, and measuring the response beyond what is caused by the hydrogen alone. This instrument requires a hydrogen supply, contained in a small tank in the instrument. This hydrogen, including the gas in the instrument tank, is considered a flammable gas and appropriate requirements must be adhered to when shipping. The instrument shall be emptied of hydrogen before shipping. Federal Express Hazardous Material shipping manifests must be completed when shipping the gas.

The hydrogen gas in the FID combustion chamber is ignited by pressing a red button on the side of the instrument, which sends electrical current to a small resistance coil igniter in the combustion chamber. This igniter is very sensitive, and if the red button is pressed for longer than 5 seconds, the coil will burn out and the instrument will be unusable unless another igniter is available. If the instrument will not light, check the electrical connections and switches for proper settings. Check that the pump is pumping, and allow fresh air to flow through the combustion chamber for several minutes before lighting. Check to see if the exhaust port of the combustion chamber is dirty.

3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that field activities are conducted in accordance with this procedure and any other SOPs pertaining to the specific activity.

Field Team Leader - The field team leader is responsible for ensuring that field personnel conduct field activities in accordance with this and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment

- Site-specific plans
- Field logbook
- Waterproof black ink pen
- Personal protective clothing and equipment
- Photoionization detector or flame ionization detector
- Calibration gases in a range appropriate for the expected use
- 0.5 liter (16-ounce) or "Mason" type glass jar
- Hydrogen Canister and fill valve and hose (if using FID for a period of more than 1 day)

5.0 Procedures

5.1 Direct Reading Measurement

1. Connect the measurement probe to the instrument and make necessary operational checks (e.g., battery check, etc.) as outlined in the manufacturer's manual.

2. Calibrate the instrument following the applicable manufacturer's manual

3. Make sure the instrument is reading zero and all function and range switches are set appropriately.

4. Insert the end of the probe directly into the atmosphere to be measured (e.g., breathing zone, monitoring well casing, split spoon, etc.) and read the organic vapor concentration in parts per million (ppm) from the instrument display. Apply the appropriate correction factor if necessary. Record the highest instrument response.

5. Immediately document the reading in the field logbook or on the appropriate field form.

5.2 Headspace Measurement

1. Connect the measurement probe to the instrument and make necessary operational checks (e.g., battery check, etc.) as outlined in the manufacturer's manual.

2. Calibrate the instrument following the appropriate manufacturer's manual.

3. Make sure the instrument is reading zero and all function and range switches are set appropriately.

4. Fill a clean glass jar approximately half-full of the sample to be measured. Quickly cover the top of the jar with one or two sheets of clean aluminum foil and apply cap to seal the jar.

5. Allow headspace to develop for approximately 10 minutes. It is generally preferable to shake the sealed jar for 10 to 15 seconds at the beginning and end of headspace development.

Note: When the ambient temperature is below 0°C (32°F), the headspace development and subsequent measurement shall occur within a heated vehicle or building.

6. Remove the jar cap and quickly puncture the foil and insert the instrument probe to a point approximately one-half of the headspace depth. Do not let the probe contact the soil. If using a PID and there is condensation on the inside of the jar, only leave the probe in the jar long enough to obtain a reading. Remove the probe and allow fresh air to flow through the instrument to avoid excess water vapor to build up.

7. Read the organic vapor concentration in ppm from the instrument display. Apply the appropriate correction factor if necessary. Record the highest instrument response.

8. Immediately record the reading in the field logbook or on the appropriate field form.

6.0 Restrictions/Limitations

The two methods outlined above are the most commonly used for field measurement of organic vapors but do not apply to all circumstances. Consult project- or program-specific procedures and guidelines for deviations. Both the PID and FID provide quantitative measurement of organic vapors, but generally neither instrument is compound-specific. The typical reading range of the PID is 0 to 2,000 ppm, and the typical reading range of the FID is 0 to 1,000 ppm. The FID will measure methane while the PID will not. ***Note***: The presence of methane will cause erratic PID measurements. In methane rich environments, toxic organic vapors shall be monitored with an FID. If desired, a charcoal filter can be placed temporarily on the FID inlet probe, which will trap all organic vapors except methane. The filtered (methane only) reading can be subtracted from unfiltered (total organic vapors) to provide an estimate of non-methane organic vapors. The reading accuracy of both instruments can be affected by ambient temperature, barometric pressure, humidity, lithology, etc.

7.0 References

Martin Marietta Energy Systems, Inc. 1998. *Environmental Surveillance Procedures Quality Control Program*, ESH/Sub/87-21706/1.

TSOP 2-1

PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES

SOP No.: 2 - 1
Revision: 3
Date: October 20, 2004

QA Review: J Oxford

Approved and Issued: J Peterson 11/4/04
Program Manager Signature/Date

Contract No.: RAC II   Client: EPA Region II

Reason for Clarification: Make SOP EPA Region II - Specific

1.3 REQUIRED EQUIPMENT

Add to the list of equipment:

- Paint can-type metal cans with lids, clean (optional)

1.4 PROCEDURES

Under Step 2, add:

Clean to the description of the cooler used to transport samples.

Under Step 4, add:

- If bubble wrap or other wrapping material will be placed around the labeled containers, write the sample number and analysis on the outside of the wrap, and then place wrapped container in a plastic zip-top bag and close the bag.

- If samples are determined to be of medium or high hazard by visual observation or instrument reading, or if the sample is known to contain dioxin, all such sample bottles will be placed in waterproof plastic bags and then placed in a metal can (paint can). Vermiculite will be used to secure the bottles within the metal can, and clips or tape will be used to permanently hold the can lid tightly in place. One bottle is packed per can. The metal cans will be labeled as the sample bottle is labeled. High level samples will not be cooled to 4^0 centigrade.

- Note: A labeled cooler temperature blank must be added to each cooler.

Under Step 4, remove the sentence:
"Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent".

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 2 - 1
Revision: 3
Date: October 20, 2004

SOP Title: **PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES**

Under Step 9, add:

At least two custody seals must be attached to each cooler at diagonally opposing corners.

Under Step 10, add:

The outside of the cooler must be marked "Environmental Samples" if the samples are designated "Low-Level."

Bills of Lading (DOT shipping papers) are required only for shipment of medium- or high-level samples. Shipment of medium- or high-level samples are as per the *Contract Laboratory Program (CLP) Guidance for Field Samplers* (June 2001).

8.0 REFERENCES

Remove:
U.S. Environmental Protection Agency, *Sampler's Guide to the Contract Laboratory Program,* EPA/540/P-90/006, December 1990.

Add:
U.S. Environmental Protection Agency. 2004. *Contract Laboratory Program (CLP) Guidance for Field Samplers,* Final. EPA-540-R-00-003. August.

Packaging and Shipping Environmental Samples

SOP 2-1
Revision: 3
Date: March 2007

Prepared:	Krista Lippoldt	**Technical Review:**	Chuck Myers
QA Review:	Jo Nell Mullins	**Approved:**	E-Signed by Michael C. Malloy VERIFY authenticity with ApproveIt Signature/Date
Issued:	E-Signed by P. Michael Schwan VERIFY authenticity with ApproveIt Signature/Date		

1.0 Objective

The objective of this SOP is to outline the requirements for the packaging and shipment of environmental samples. Additionally, Sections 2.0 through 7.0 outline requirements for the packaging and shipping of regulated environmental samples under the Department of Transportation (DOT) Hazardous Materials Regulations, the International Air Transportation Association (IATA), and International Civil Aviation Organization (ICAO) Dangerous Goods Regulations for shipment by air and applies only to domestic shipments. This SOP does not cover the requirements for packaging and shipment of equipment (including data loggers and self-contained breathing apparatus [SCBAs] or bulk chemicals that are regulated under the DOT, IATA, and ICAO.

1.1 Packaging and Shipping of All Samples

This standard operating procedure (SOP) applies to the packaging and shipping of all environmental samples. If the sample is preserved or radioactive, the following sections may also be applicable.

Section 2.0 - Packaging and Shipping Samples Preserved with Methanol
Section 3.0 - Packaging and Shipping Samples Preserved with Sodium Hydroxide
Section 4.0 - Packaging and Shipping Samples Preserved with Hydrochloric Acid
Section 5.0 - Packaging and Shipping Samples Preserved with Nitric Acid
Section 6.0 - Packaging and Shipping Samples Preserved with Sulfuric Acid
Section 7.0 - Packaging and Shipping Limited-Quantity Radioactive Samples

1.2 Background

1.2.1 Definitions

Environmental Sample - An aliquot of air, water, plant material, sediment, or soil that represents the contaminant levels on a site. Samples of potential contaminant sources, like tanks, lagoons, or non-aqueous phase liquids are normally not "environmental" for this purpose. This procedure applies only to environmental samples that contain less than reportable quantities for any foreseeable hazardous constituents according to DOT regulations promulgated in 49 CFR - Part 172.101 Appendix A.

Custody Seal - A custody seal is a narrow adhesive-backed seal that is applied to individual sample containers and/or the container (i.e., cooler) before offsite shipment. Custody seals are used to demonstrate that sample integrity has not been compromised during transportation from the field to the analytical laboratory.

Inside Container - The container, normally made of glass or plastic, that actually contacts the shipped material. Its purpose is to keep the sample from mixing with the ambient environment.

Outside Container - The container, normally made of metal or plastic, that the transporter contacts. Its purpose is to protect the inside container.

Secondary Containment - The outside container provides secondary containment if the inside container breaks (i.e., plastic overpackaging if liquid sample is collected in glass).

Excepted Quantity - Excepted quantities are limits to the mass or volume of a hazardous material in the inside and outside containers below which DOT, IATA, ICAO regulations do not apply. The excepted quantity limits are very low. Most regulated shipments will be made under limited quantity.

Limited Quantity - Limited quantity is the maximum amount of a hazardous material below which there are specific labeling or packaging exceptions.

Performance Testing - Performance testing is the required testing of outer packaging. These tests include drop and stacking tests.

Qualified Shipper - A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

1.2.2 Associated Procedures
- CDM Federal SOP 1-2, *Sample Custody*

1.2.3 Discussion
Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis. These shipments are potentially subject to regulations published by DOT, IATA, or ICAO. Failure to abide by these rules places both CDM and the individual employee at risk of serious fines. The analytical holding times for the samples must not be exceeded. The samples shall be packed in time to be shipped for overnight delivery. Make arrangements with the laboratory before sending samples for weekend delivery.

1.3 Required Equipment
- Coolers with return address of the appropriate CDM office
- Heavy-duty plastic garbage bags
- Plastic zip-type bags, small and large
- Clear tape
- Nylon reinforced strapping tape
- Duct tape
- Vermiculite (or an equivalent nonflammable material that is inert and absorbent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Completed chain-of-custody record or contract laboratory program (CLP) custody records, if applicable
- Completed bill of lading
- "This End Up" and directional arrow labels

*Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

1.4 Packaging Environmental Samples
The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "environmental sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the appropriate health and safety coordinator or the health and safety manager shall be observed.

2. Select a sturdy cooler in good repair. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler. Line the cooler with a large heavy-duty plastic garbage bag.

3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SOP 1-2, Sample Custody).

4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Binding the vials together with a rubber band on the outside of the bag, or separating them so that they do not contact each other, will reduce the risk of breakage. Bottles may be wrapped in bubble wrap. Optionally place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent. ***Note***: Trip blanks must be included in coolers containing VOA samples.

5. Place 2 to 4 inches of vermiculite (or equivalent) into a cooler that has been lined with a garbage bag, and then place the bottles and cans in the bag with sufficient space to allow for the addition of packing material between the bottles and cans. It is preferable to place glass sample bottles and jars into the cooler vertically. Glass containers are less likely to break when packed vertically rather than horizontally.

6. While placing sample containers into the cooler, conduct an inventory of the contents of the shipping cooler against the chain-of-custody record. The chain-of-custody with the cooler shall reflect only those samples within the cooler.

7. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place the ice bags on top of and/or between the samples. Several bags of ice are required (dependant on outdoor temperature, staging time, etc.) to maintain the cooler temperature at approximately 4° Celsius (C) if the analytical method requires cooling. Fill all remaining space between the bottles or cans with packing material. Securely fasten the top of the large garbage bag with fiber or duct tape.

8. Place the completed chain-of-custody record or the CLP traffic report form (if applicable) for the laboratory into a plastic zip-top bag, seal the bag, tape the bag to the inner side of the cooler lid and close the cooler.

9. The cooler lid shall be secured with nylon reinforced strapping tape by wrapping each end of the cooler a minimum of two times. Attach a completed chain-of-custody seal across the opening of the cooler on opposite sides. The custody seals shall be affixed to the cooler with half of the seal on the strapping tape so that the cooler cannot be opened without breaking the seal. Complete two more wraps around with fiber tape and place clear tape over the custody seals.

10. The shipping container lid must be marked **"THIS END UP"** and arrow labels that indicate the proper upward position of the container shall be affixed to the cooler. A label containing the name and address of the shipper (CDM) shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted on the outside of containers used to transport environmental samples and shall not be used. The name and address of the laboratory shall be placed on the container, or when shipping by common courier, the bill of lading shall be completed and attached to the lid of the shipping container.

2.0 Packaging and Shipping Samples Preserved with Methanol

2.1 Containers

- The maximum volume of methanol in a sample container is limited to 30 ml.
- The sample container must not be full of methanol.

2.2 Responsibility

It is the responsibility of the qualified shipper to:

- Ensure that the samples undergoing shipment contain no other contaminant that meets the definition of "hazardous material" as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

2.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packing may consist of glass or plastic jars
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 3 flammable liquid labels
- Orientation labels
- Consignor/consignee labels

2.4 Packaging Samples Preserved with Methanol

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (Maximum of 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
- Total volume of methanol per shipping container must not exceed 500 ml.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

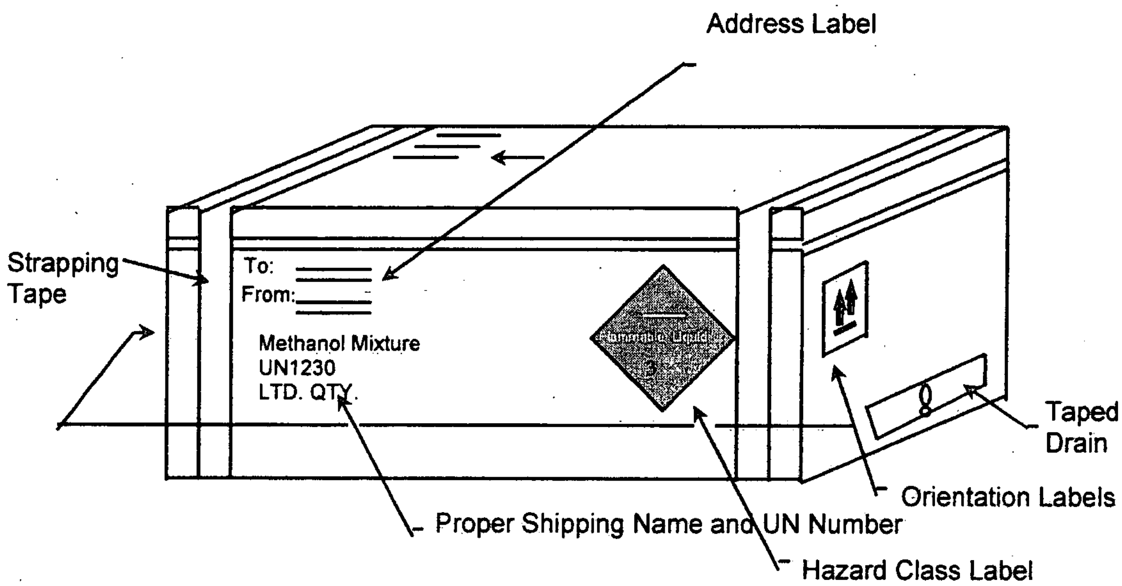
    Methanol Mixture
    UN1230
    LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Flammable Liquid label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: No marking or labeling can be obscured by strapping or duct tape.
Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

Figure 1
Example of Cooler Label/Marking Locations



3.0 Packaging and Shipping Samples Preserved with Sodium Hydroxide

3.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sodium Hydroxide Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
NaOH	30%	>12	0.08%		.25	0.5	1	2

5 drops = 1 ml

3.2 Responsibility

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

3.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Inner packings may consist of glass or plastic jars no larger than 1 pint
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

3.4 Packaging Samples Preserved with Sodium Hydroxide

Samples containing NaOH as a preservative that exceed the excepted concentration of 0.08 percent (2 ml of a 30 percent NaOH solution per liter) may be shipped as a limited quantity per packing instruction Y819 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- The total volume of sample in each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

  Sodium Hydroxide Solution
  UN1824
  LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples meeting the exception concentration of 0.08 percent NaOH by weight may be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

4.0 Packaging and Shipping Samples Preserved with Hydrochloric Acid

4.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Hydrochloric Acid Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container		
		pH	Conc.	40 ml	125 ml	250 ml
HCl	2N	<1.96	0.04%	.2	.5	1

5 drops = 1 ml

4.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

4.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Inner packing may consist of glass or plastic jars no larger than 1 pint.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

4.4 Packaging Samples Preserved with Hydrochloric Acid

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (No more than 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)

- Total volume of sample inside each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Hydrochloric Acid Solution
UN1789
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples containing less than the exception concentration of 0.04 percent HCl by weight will be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

5.0 Packaging and Shipping Samples Preserved with Nitric Acid

5.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Nitric Acid Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
HNO_3	6N	<1.62	0.15%		2	4	5	8

5 drops = 1 mg/L

5.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

5.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

5.4 Packaging Samples Preserved with Nitric Acid

Samples containing HNO_3 as a preservative that exceed the excepted concentration of 0.15 percent HNO_3 will be shipped as a limited quantity per packing instruction Y807 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Nitric Acid Solution (with less than 20 percent)
UN2031
Ltd. Qty.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

  Note: Samples meeting the exception concentration of 0.15 percent HNO_3 by weight will be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

  Note: No marking or labeling can be obscured by strapping or duct tape.

  Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

6.0 Packaging and Shipping Samples Preserved with Sulfuric Acid

6.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sulfuric Acid Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
H_2SO_4	37N	<1.15	0.35%	.1	.25	0.5	1	2

5 drops = 1 ml

6.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

6.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

6.4 Packaging of Samples Preserved with Sulfuric Acid

Samples containing H_2SO_4 as a preservative that exceed the excepted concentration of 0.35 percent will be shipped as a limited quantity per packing instruction Y809 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each glass container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

  Sulfuric Acid Solution
  UN2796
  LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples containing less than the exception concentration of 0.35 percent H_2SO_4 by weight will be shipped as nonregulated or nonhazardous in accordance with the procedure described in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

7.0 Packaging and Shipping Limited-Quantity Radioactive Samples

7.1 Containers

The inner packaging containers that may be used for these shipments include:

- Any size sample container

7.2 Description/Responsibilities

- The qualified shipper will determine that the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT.
- The qualified shipper will ship all samples that meet the Class 7 definition of radioactive materials and meet the activity requirements specified in Table 7 of 49 CFR 173.425, as Radioactive Materials in Limited Quantity. The qualified shipper will verify that all packages and their contents meet the requirements of 49 CFR 173.421, *Limited Quantities of Radioactive Materials*.
- The packaging used for shipping will meet the general requirements for packaging and packages specified in 49 CFR 173.24 and the general design requirements provided in 173.410. These standards state that a package must be capable of withstanding the effects of any acceleration, vibration, or vibration resonance that may arise under normal condition of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use.
- If the shipment is from a DOE facility, radiological screenings will be completed on all samples taken. The qualified shipper will review the results of each screening (alpha, beta, and gamma speciation). Samples will not be shipped offsite until the radiological screening has been performed.
- The total activity for each package will not exceed the relevant limits listed in Table 7 of 49 CFR 173.425. The A_2 value of the material will be calculated based on all radionuclides found during previous investigations (if any) in the area from which the samples are derived. The A_2 values to be used will be the most restrictive of all potential radionuclides as listed in 49 CFR 173.435.
- The radiation level at any point on the external surface of the package bearing the sample(s) will not exceed 0.005 mSv/hour (0.5 mrem/hour). These will be verified by dose and activity monitoring before shipment of the package.
- The removable radioactive surface contamination on the external surface of the package will not exceed the limits specified in 49 CFR 173.443(a). CDM will apply the DOE-established free release criteria for removable surface contamination of less than 20 dpm/100 cm^2 (alpha) and 1,000 dpm/100 cm^2 (beta/gamma). It shall be noted that these values are more conservative than the DOT requirements for removable surface contamination.
- The qualified shipper will verify that the outside of the inner packaging is marked "Radioactive."
- The qualified shipper will verify that the excepted packages prepared for shipment under the provisions of 49 CFR 173.421 have a notice enclosed, or shown on the outside of the package, that reads, **"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."**

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

7.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Survey documentation/radiation screening results (if shipping from DOE or radiological sites)
- Orientation labels
- Excepted quantities label
- Consignor/consignee labels

7.4 Packaging of Limited-Quantity Radioactive Samples

The following steps are to be followed when packaging limited-quantity sample shipments:

- The cooler is to be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place sufficient amount of vermiculite, or approved packaging material, in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- If required, place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- Place a label marked Radioactive on the outside of the sealed bag.
- Enclose a notice that includes the name of the consignor or consignee and the following statement: ***"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."***
- Note that both DOT and IATA apply different limits to the quantity in the inside packing and in the outside packing.
- The maximum weight of the package shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- If a cooler is used, wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix package orientation labels on two opposite sides of the cooler/package.
- Affix a completed Excepted Quantities label to the side of the cooler/package.
- Secure any marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.

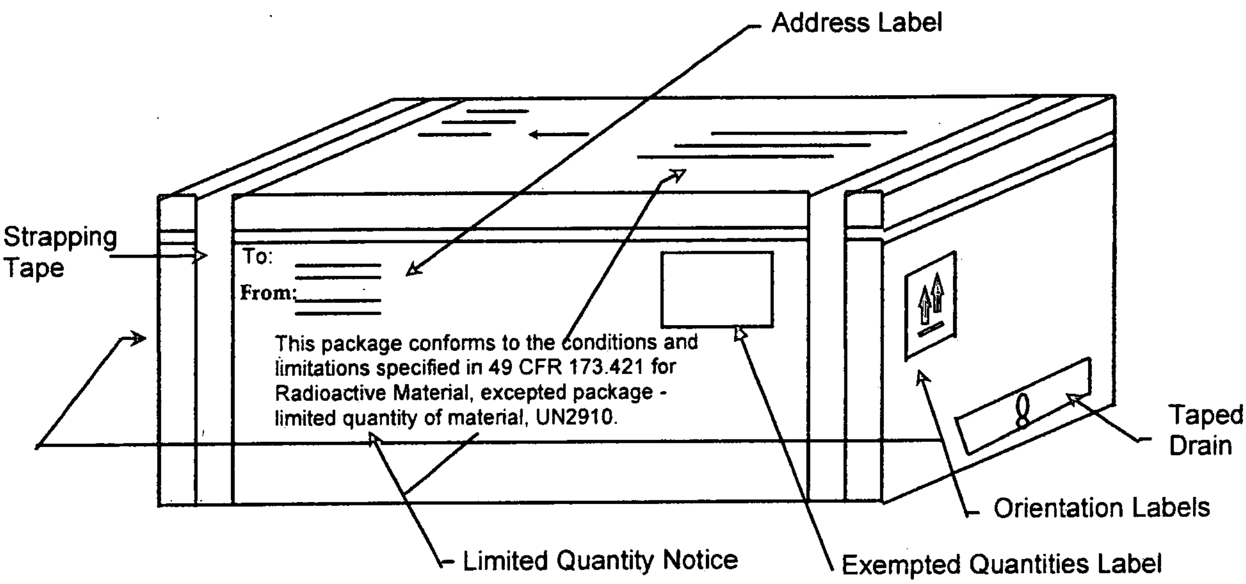
An example of the cooler labeling/marking is shown in Figure 2.

Note: No marking or labeling can be obscured by strapping or duct tape.

- Complete the Shipment Quality Assurance Checklist (Appendix B).

Note: Except as provided in 49 CFR 173.426, the package will not contain more than 15 grams of ^{235}U.
Note: A declaration of dangerous goods is not required.

Figure 2
Radioactive Material – Limited-Quantity Cooler Marking Example



8.0 References

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Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Hazardous Materials Table, Special Provisions, Hazardous, Materials Communications, Emergency Response Information, and Training Requirements*, 49 CFR 172.

Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Shippers General Requirements for Shipments and Packagings*, 49 CFR 173.

Appendix A

Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity

Sample Packaging

Yes	No	N/A	
❑	❑	❑	The VOA vials are wrapped in bubble wrap and placed inside a zip-type bag.
❑	❑	❑	The VOA vials are placed into a polyethylene bottle, filled with vermiculite, and tightly sealed.
❑	❑	❑	The drain plug is taped inside and outside to ensure control of interior contents.
❑	❑	❑	The samples have been placed inside garbage bags with sufficient bags of ice to preserve samples at 4°C.
❑	❑	❑	The cooler weighs less than the 66-pound limit for limited-quantity shipment.
❑	❑	❑	The garbage bag has been sealed with tape (or tied) to prevent movement during shipment.
❑	❑	❑	The chain-of-custody has been secured to the interior of the cooler lid.
❑	❑	❑	The cooler lid and sides have been taped to ensure a seal.
❑	❑	❑	The custody seals have been placed on both the front and back hinges of the cooler, using waterproof tape.

Air Waybill Completion

Yes	No	N/A	
❑	❑	❑	Section 1 has the shipper's name, company, and address; the account number, date, internal billing reference number; and the telephone number where the shipper can be reached.
❑	❑	❑	Section 2 has the recipient's name and company along with a telephone number where they can be reached.
❑	❑	❑	Section 3 has the **Bill Sender** box checked.
❑	❑	❑	Section 4 has the **Standard Overnight** box checked.
❑	❑	❑	Section 5 has the **Deliver Weekday** box checked.
❑	❑	❑	Section 6 has the number of packages and their weights filled out. Was the total of all packages and their weights figured up and added at the bottom of Section 6?
❑	❑	❑	Under the **Transport Details** box, the **Cargo Aircraft Only** box is obliterated, leaving only the **Passenger and Cargo Aircraft** box.
❑	❑	❑	Under the **Shipment Type**, the **Radioactive** box is obliterated, leaving only the **Non-Radioactive** box.
❑	❑	❑	Under the **Nature and Quantity of Dangerous Goods** box, the **Proper Shipping Name, Class or Division, UN or ID No., Packing Group, Subsidiary Risk, Quantity and Type of Packing, Packing Instructions, and Authorization** have been filled out for the type of chemical being sent.
❑	❑	❑	The **Name, Place and Date, Signature, and Emergency Telephone Number** appears at the bottom of the FedEx Airbill.
❑	❑	❑	The statement "In accordance with IATA/ICAO" appears in the **Additional Handling Information** box.
❑	❑	❑	The **Emergency Contact Information** at the bottom of the FedEx Airbill is truly someone who can respond any time of the day or night.

Proper Shipping Name	Class or Division	UN or ID No.	Packing Group	Sub Risk	Quantity	Packing Instruction	Authorization
Hydrochloric Acid Solution	8	UN1789	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Nitric Acid Solution (with less than 20%)	8	UN2031	II		1 plastic box × 0.5 L	Y807	Ltd. Qty.
Sodium Hydroxide Solution	8	UN1824	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Sulfuric Acid Solution	8	UN2796	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Methanol	3	UN1230	II		1 plastic box × 1 L	Y305	Ltd. Qty.

Sample Cooler Labeling

Yes	No	N/A	
❑	❑	❑	The proper shipping name, UN number, and Ltd. Qty. appears on the shipping container.
❑	❑	❑	The corresponding hazard labels are affixed on the shipping container; the labels are not obscured by tape.
❑	❑	❑	The name and address of the shipper and receiver appear on the top and side of the shipping container.
❑	❑	❑	The air waybill is attached to the top of the shipping container.
❑	❑	❑	**Up Arrows** have been attached to opposite sides of the shipping container.
❑	❑	❑	Packaging tape does not obscure markings or labeling.

Appendix B

Shipment Quality Assurance Checklist

Date: ______________ Shipper: ______________________________ Destination: ___________________________

Item(s) Description: ____

Radionuclide(s): ____

Radiological Survey Results: surface _________________mrem/hr 1 meter ____________________

Instrument Used: Mfgr: ____________________________________ Model: ____________________________

S/N: ____ Cal Date: ___________________________

Limited-Quantity or Instrument and Article

Yes	No	
___	___	1. Strong tight package (package that will not leak material during conditions normally incidental to transportation).
___	___	2. Radiation levels at any point on the external surface of package less than or equal to 0.5 mrem/hr.
___	___	3. Removable surface contamination less than 20 dpm/100 cm^2 (alpha) and 1,000 dpm/100 cm^2 (beta/gamma).
___	___	4. Outside inner package bears the marking "Radioactive."
___	___	5. Package contains less than 15 grams of ^{235}U (check yes if ^{235}U not present).
___	___	6. Notice enclosed in or on the package that includes the consignor or consignee and the statement, **"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."**
___	___	7. Activity less than that specified in 49 CFR 173.425. Permissible package limit: Package Quantity:
___	___	8. On all air shipments, the statement **Radioactive Material, excepted package-limited quantity of material** shall be noted on the air waybill.

Qualified Shipper: ___________________________ Signature: ____________________________________

TSOP 2-2

GUIDE TO HANDLING OF INVESTIGATION DERIVED WASTE

Guide to Handling Investigation-Derived Waste

SOP 2-2
Revision: 5
Date: March 2007

Prepared: Tim Eggert

Technical Review: Matt Brookshire

QA Review: Jo Nell Mullins

Approved: E-Signed by Michael C. Malloy VERIFY authenticity with ApproveIt

Signature/Date

Issued: E-Signed by P. Michael Schwan VERIFY authenticity with ApproveIt

Signature/Date

1.0 Objective

This standard operating procedure (SOP) presents guidance for the management of investigation-derived waste (IDW). The primary objectives for managing IDW during field activities include:

- Leaving the site in no worse condition than existed before field activities
- Removing wastes that pose an immediate threat to human health or the environment
- Proper handling of onsite wastes that do not require offsite disposal or extended aboveground containerization
- Complying with federal, state, local, and facility applicable or relevant and appropriate requirements (ARARs)
- Careful planning and coordination of IDW management options
- Minimizing the quantity of IDW

2.0 Background

2.1 Definitions

Hazardous Waste - Discarded material that is regulated listed waste, or waste that exhibits ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.3 or state regulations.

Investigation-Derived Wastes - Discarded materials resulting from field activities such as sampling, surveying, drilling, excavations, and decontamination processes that, in present form, possess no inherent value or additional usefulness without treatment. Wastes may be solid, sludge, liquid, gaseous, or multiphase materials that may be classified as hazardous or nonhazardous.

Mixed Waste - Any material that has been classified as hazardous and radioactive.

Radioactive Wastes - Discarded materials that are contaminated with radioactive constituents with specific activities in concentrations greater than the latest regulatory criteria (i.e., 10 CFR 20).

Treatment, Storage, and Disposal Facility (TSDF) - Permitted facilities that accept hazardous waste shipments for further treatment, storage, and/or disposal. These facilities must be permitted by the U. S. Environmental Protection Agency (EPA) and appropriate state and local agencies.

2.2 Discussion

Field investigation activities result in the generation of waste materials that may be characterized as hazardous or radioactive waste. IDWs may include drilling muds, cuttings, and purge water from test pit and well installation; purge water, soil, and other materials from collection of samples; residues from testing of treatment technologies and pump and treat systems; personal protective equipment (PPE); solutions (aqueous or otherwise) used to decontaminate nondisposable protective clothing and equipment; and other wastes or supplies used in sampling and testing potentially hazardous or radiologically contaminated material.

Note: The client's representatives may not be aware of all potential contaminants. The management of IDW must comply with applicable regulatory requirements.

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that all IDW procedures are conducted in accordance with this SOP. The site manager is also responsible for ensuring that handling of IDW is in accordance with site-specific requirements.

Project Manager - The project manager is responsible for identifying site-specific requirements for the disposal of IDW in accordance with federal, state, and/or facility requirements.

Field Crew Members - Field crew members are responsible for implementing this SOP and communicating any unusual or unplanned condition to the project manager's attention.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/project specific quality assurance plan.

4.0 Required Equipment

Equipment required for IDW containment will vary according to site-specific/client requirements. Management decisions concerning the necessary equipment required shall consider: containment method, sampling, labeling, maneuvering, and storage (if applicable). Equipment must be onsite and inspected before commencing work.

4.1 IDW Containment Devices

The appropriate containment device (drums, tanks, etc.) will depend on site- or client-specific requirements and the ultimate disposition of the IDW. Typical IDW containment devices can include:

- Plastic sheeting (polyethylene) with a minimum thickness of 20 millimeters
- Department of Transportation (DOT)-approved steel containers
- Polyethylene or steel bulk storage tanks

Containment of IDW shall be segregated by waste type (i.e., solid or liquid, corrosive or flammable, etc.) and source location. Volume of the appropriate containment device shall be site-specific.

4.2 IDW Container Labeling

A "Waste Container" or "IDW Container" label or indelible marking shall be applied to each container. Labeling or marking requirements for onsite IDW not expected to be transported offsite are:

- Labels and markings that contain the following information: project name, generation date, location of waste origin, container identification number, sample number (if applicable), and contents (drill cuttings, purge water, PPE, etc.).
- Each label or marking will be applied to the upper one-third of the container at least twice, on opposite sides.
- Containers that are 5 gallons or less may only require one label or set of markings.
- Labels or markings will be positioned on a smooth part of the container. The label must not be affixed across container bungs, seams, ridges, or dents.
- Labels must be constructed of a weather-resistive material with markings made with a permanent marker or paint pen and capable of enduring the expected weather conditions. If markings are used, the color must be easily distinguishable from the drum color.
- Labels will be secured in a manner to ensure the label remains affixed to the container.

Labeling or marking requirements for IDW expected to be transported offsite must be in accordance with the requirements of 49 CFR 172.

4.3 IDW Container Movement

Staging areas for IDW containers shall be predetermined and in accordance with site-specific and/or client requirements. Arrangements shall be made before field mobilization as to the methods and personnel required to safely transport IDW containers to the staging area. Transportation offsite onto a public roadway is prohibited unless 49 CFR 172 requirements are met.

4.4 IDW Container Storage

Containerized IDW shall be staged pending chemical analysis or further onsite treatment. Staging areas and bulk storage procedures are to be determined according to site-specific requirements. Containers are to be stored in such a fashion that the labels can be easily read. A secondary/spill container must be provided for liquid IDW storage and as appropriate for solid IDW storage.

5.0 Procedures

The three general options for managing IDW are (1) collection and onsite disposal, (2) collection for offsite disposal, and (3) collection and interim management. Attachment 1 summarizes media-specific information on generation processes and management options. The option selected shall take into account the following factors:

- Type (soil, sludge, liquid, debris), quantity, and source of IDW
- Risk posed by managing the IDW onsite
- Compliance with regulatory requirements
- IDW minimization and consistency with the IDW remedy and the site remedy

In all cases the client shall approve the plans for IDW. Formal plans for the management of IDW must be prepared as part of a work plan or separate document.

5.1 Collection and Onsite Disposal

5.1.1 Soil/Sludge/Sediment

The options for handling soil/sludge/sediment IDW are as follows:

1. Return to boring, pit, or source immediately after generation as long as returning the media to these areas will not increase site risks (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate “clean” areas).

2. Spread around boring, pit, or source within the area of contamination (AOC) as long as returning the media to these areas will not increase site risks (e.g., direct contact with surficial contamination).

3. Consolidate in a pit within the AOC as long as returning the media to these areas will not increase site risks (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate “clean” areas).

4. Send to onsite TSDF - may require analytical analysis before treatment/disposal.

Note: These options may require client and/or regulatory approval.

5.1.2 Aqueous Liquids

The options for handling aqueous liquid IDW are as follows:

1. Discharge to surface water, only when IDW is not contaminated.

2. Discharge to ground surface close to the well, only if soil contaminants will not be mobilized in the process and the action will not contaminate clean areas. If IDW from the sampling of background upgradient wells is not a community concern or associated with soil contamination, this presumably uncontaminated IDW may be released on the ground around the well.

3. Discharge to sanitary sewer, only when IDW is not contaminated.

4. Send to onsite TSDF - may require analysis before treatment/disposal.

Note: These options may require analytical results to obtain client and/or regulatory approval.

5.1.3 Disposable PPE

The options for handling disposable PPE are as follows:

1. Double-bag contents in nontransparent trash bags and place in onsite industrial dumpster, only if PPE is not contaminated.

2. Containerize, label, and send to onsite TSDF - may require analysis before treatment/disposal.

5.2 Collection for Offsite Disposal

Before sending to an offsite TSDF, analysis may be required. Manifests are required. In some instances, a bill of lading can be used for nonhazardous solid IDW (i.e., wooden pallets, large quantities of plastic sheeting). Arrangements must be made with the client responsible for the site to sign as generator on any waste profile and all manifests or bill of ladings; it is CDM's policy not to sign manifests. The TSDF and transporter must be permitted for the respective wastes. Nonbulk containers (e.g., drums) must have a DOT-approved label adhered to the container and all required associated placard stickers before leaving for a TSDF off site. These labels must include information as required in 49 CFR 172. Bulk containers (i.e., rolloffs, tanks) do not require container specific labels for transporting off site, but must include appropriate placards as required in 49 CFR 172.

5.2.1 Soil/Sludge/Sediment

When the final site remedy requires offsite treatment and disposal, the IDW may be stored (e.g., drummed, covered in a waste pile) or returned to its source until final disposal. The management option selected shall take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.2 Aqueous Liquids

When the final site remedy requires offsite treatment and disposal, the IDW may be stored (e.g., mobile tanks or drums with appropriate secondary containment) until final disposal. The management option selected shall take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.3 Disposable PPE

When the final site remedy requires offsite treatment disposal, the IDW may be containerized and stored. The management option selected shall take into account potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.3 Collection and Interim Management

All interim measures must be approved by the client and regulatory agencies.

1. Storing IDW onsite until the final action may be practical in the following situations:
   - Returning wastes (especially sludges and soils) to their onsite source area would require reexcavation for disposal in the final remediation alternative.
   - Interim storage in containers may be necessary to provide adequate protection to human health and the environment.
   - Offsite disposal options may trigger land disposal regulations under the Resource Conservation and Recovery Act (RCRA). Storing IDW until the final disposal of all wastes from the site will eliminate the need to address this issue more than once.
   - Interim storage may be necessary to provide time for sampling and analysis.

2. Segregate and containerize all waste for future treatment and/or disposal.
   - Containment options for soil/sludge/sediment may include drums or covered waste piles in AOC.
   - Containment options for aqueous liquids may include mobile tanks or drums.
   - Containment options for PPE may include drums or roll-off boxes.

6.0 Restrictions/Limitations

Site Managers Shall Determine the Most Appropriate Disposal Option for Aqueous Liquids on a Site-Specific Basis. Parameters to consider, especially when determining the level of protection, include the volume of IDW, the contaminants present in the groundwater, the presence of contaminants in the soil at the site, whether the groundwater or surface water is a drinking water supply, and whether the groundwater plume is contained or moving. Special disposal/handling may be needed for drilling fluids because they may contain significant solid components.

Disposable sampling materials, disposable PPE, decontamination fluids, etc. will always be managed on a site-specific basis. **Under No Circumstances Shall These Types of Materials Be Brought Back to the Office or Warehouse**.

7.0 References

Environmental Resource Center. 1997. *Hazardous Waste Management Compliance Handbook 2nd Edition*. Karnofsky (Editor).

Academy of Certified Hazardous Materials Manager. May 1999. *Hazardous Materials Management Desk Reference*. Cox.

Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Hazardous Materials Table, Special Provisions, Hazardous, Materials Communications, Emergency Response Information, and Training Requirements*, 49 CFR 172.

U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.1.

__________. August 1990. *Low-Level Mixed Waste: A RCRA Perspective for NRC Licensees*, EPA/530-SW-90-057.

__________. May 1991. *Management of Investigation-Derived Wastes During Site Inspections*, EPA/540/G-91/009.

__________. January 1992. *Guide to Management of Investigation-Derived Wastes*, 9345.3-03FS.

__________. Region IV. November 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual.*

Attachment 1
IDW Management Options

Type of IDW	Generation Processes	Management Options
Soil	▫ Well/Test pit installations ▫ Borehole drilling ▫ Soil sampling	**Onsite Disposal** ▫ Return to boring, pit, or source immediately after generation ▫ Spread around boring, pit, or source within the AOC ▫ Consolidate in a pit (within the AOC) ▫ Send to onsite TSDF **Offsite Disposal** ▫ Client to send to offsite TSDF **Interim Management** ▫ Store for future treatment and/or disposal
Sludge/Sediment	▫ Sludge pit/sediment sampling	**Onsite Disposal** ▫ Return to boring, pit, or source immediately after generation ▫ Send to onsite TSDF **Offsite Disposal** ▫ Client to send to offsite TSDF **Interim Management** ▫ Store for future treatment and/or disposal
Aqueous Liquids (groundwater, surface water, drilling fluids, wastewaters)	▫ Well installation/development ▫ Well purging during sampling ▫ Groundwater discharge during pump tests ▫ Surface water sampling ▫ Wastewater sampling	**Onsite Disposal** ▫ Pour onto ground close to well (nonhazardous waste) ▫ Discharge to sewer ▫ Send to onsite TSDF **Offsite Disposal** ▫ Client to send to offsite commercial treatment unit ▫ Client to send to publicly owned treatment works (POTW) **Interim Management** ▫ Store for future treatment and/or disposal
Decontamination Fluids	▫ Decontamination of PPE and equipment	**Onsite Disposal** ▫ Send to onsite TSDF ▫ Evaporate (for small amounts of low contamination organic fluids) ▫ Discharge to ground surface **Offsite Disposal** ▫ Client to send to offsite TSDF ▫ Discharge to sewer **Interim Management** ▫ Store for future treatment and/or disposal
Disposable PPE and Sampling Equipment	▫ Sampling procedures or other onsite activities	**Onsite Disposal** ▫ Place in onsite industrial dumpster ▫ Send to onsite TSDF **Offsite Disposal** ▫ Client to send to offsite TSDF **Interim Management** ▫ Store for future treatment and/or disposal

Adapted from U. S. Environmental Protection Agency, *Guide to Management of Investigation-Derived Wastes*, 9345-03FS, January 1992.

TSOP 3-2

TOPOGRAPHIC SURVEY

Topographic Survey

SOP 3-2
Revision: 6
Date: March 2007

Prepared:	Demetrios Klerides	**Technical Review:**	Geoffrey McKenzie
QA Review:	Jo Nell Mullins	**Approved:**	E-Signed by Michael C. Malloy VERIFY authenticity with ApproveIt — Signature/Date
Issued:	E-Signed by P. Michael Schwan VERIFY authenticity with ApproveIt — Signature/Date		

1.0 Objective

The objective of this standard operating procedure (SOP) is to provide guidance for a site topographic survey. The survey will produce a base map of the area under study, showing topographic and site-specific features. Also, the base map will incorporate site-specific grid system coordinates, if appropriate, to show sample and exploration location, monitoring wells, test pits, and any other features required by the scope of work.

2.0 Background

A site-specific grid system may be established at the area under study to coordinate the collection of samples. The topographic survey will establish the coordinates for the grid and facilitate the transposition of the grid and sample locations from the field to the topographic base map. At areas where a grid system is not used, sample and exploration locations will be marked by the field team using appropriate markers such as stakes, nails, flagging, or paint. The base map will also locate site-specific planimetric details such as significant manmade and geographic features via the survey.

The scale for the base maps will vary based on the size of the area under study, but a suitable scale will be selected that clearly shows map features and sample locations. The base maps will be at a scale appropriate for the intended use. Areas with significant detail requirements will be shown in scale that ranges from 1 inch equals 10 feet to 1 inch equals 40 feet. Areas with less detail requirements will be shown in smaller scale such as 1 inch equals 100 feet or 200 feet. Topography will be shown with 1- or 2-foot contour intervals. However, the contour interval shall clearly identify the variation in topography to the degree necessary for the work to be performed. For example, gently sloping areas may require a smaller contour interval (i.e., 1 foot between contour lines) to reveal more subtle topographic variations. Similarly, steeply sloping areas may require larger contour intervals to legibly depict the topography. Index contours shall be indicated at elevations that are multiples of five times the contour interval.

If appropriate, aerial photographs may be used to assist in the development of the topographic base maps. Existing or new photographs can be used for this purpose. In areas with deciduous trees, new photographs shall be taken during late fall or winter when the leaves are off the trees and better ground surface image can be achieved. The scale of the aerial photographs shall provide sufficient detail for developing the topographic base map.

3.0 General Responsibilities

Project Manager - The project manager is responsible for ensuring that the topographic survey is completed in accordance with the project requirements.

Field Team Leader - The field team leader is responsible for developing the survey scope of work and ensuring that the topographic survey is coordinated properly with the grid system (if used) and the sampling points, so that the base map produced is a true representation of the field locations.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-specific/project-specific quality assurance plan.

4.0 Required Equipment

The required equipment for a topographic survey shall be provided by the selected surveyor. All equipment proposed by the surveyor shall be submitted to CDM for approval before initiating the topographic survey work.

The selected surveyor must be licensed in the state in which the survey is conducted.

For topographic surveys conducted at hazardous waste sites, all surveyor personnel who work onsite will be 40-hour health and safety trained per OSHA requirements for hazardous waste sites (29 CFR 1910.120), unless approved differently by the corporate health and safety manager.

All final drawings and maps must be signed and sealed by the licensed land surveyor.

5.0 Procedures

1. A site visit may be conducted before submitting the bid proposal. A kickoff meeting shall be held between the selected surveyor and CDM's project manager to discuss the specific requirements of the scope of work.

2. The surveyor shall be responsible for executing the work, including deed search if required.

3. The surveyor shall develop and implement a site-specific health and safety plan according to the requirements specified in the subcontract between CDM and the surveyor.

4. To the extent practical, the work shall be performed in the presence of an authorized representative(s) of CDM. CDM will interpret and clarify the specifications and will answer all questions in connection therewith.

5. The CDM field team leader will be responsible for ensuring that appropriate calibration procedures are performed and documented by the surveyor. Calibration procedures shall be consistent with the data quality objectives for the survey and with the equipment manufacturers' requirements.

6. The surveyor shall establish at least one primary horizontal control monument and one vertical benchmark, as established by the United States Coastal and Geodetic Survey (USC&GS) or equivalent authority. Additional monuments may be established by the surveyor.

7. Local benchmarks will be established at least every 500 feet or closer, if warranted by site conditions, to tie the basic control points together. Where required, established horizontal and vertical data, such as state planar coordinate systems and the national geodetic vertical datum of NAVD 88 or subsequent corrections and/or revisions, shall be used to tie the survey data to the national network.

8. Temporary monuments will be set as necessary to perform the surveying. They may be wood, metal, or otherwise marked on facilities such as sidewalks, paved streets, curbs, etc. All monuments shall be described in the field notes and marked on site maps for future reference.

9. If appropriate, the surveyor shall be encouraged to use technologies such as Global Positioning System (GPS) that will meet the accuracy requirements but that may be more flexible and efficient than traditional techniques. All geodetic control work shall conform to either the Standards and Specifications for Geodetic Control networks, Federal Geodetic Control Subcommittee or NAVSTAR Global Positioning System Surveying, U. S. Army Corps of Engineers, for third order Class II control surveys. Short traverses, less than 1 mile, may use generally accepted fourth order techniques (including vertical angles for elevations) that will provide the spatial accuracy required. Angles shall be doubled and redoubled if the mean of the doubled angle differs from the first angle by more than 10 seconds. Length measurements shall be made with a calibrated tape corrected for temperature and tension or with Electronic Distance Measuring (EDM) equipment corrected for variation of the index of refraction.

10. The CDM field team leader will review the draft map to ensure that all sampling and exploration locations, grid coordinates, and other appropriate features are located by the surveyor. The surveyor will record all field survey information in a field logbook; a copy of the logbook shall be provided to CDM with the submittal of the topographic map.

11. A working drawing of the base map will be field checked and corrected by the surveyor as necessary. The completed topographic base map shall be plotted on Mylar® or other suitable drafting film, as directed by the CDM project manager. All survey and topographical data will be in digital format, compatible with the latest version of AutoCAD, ArcView/ArcInfo, DXF, or geographic information system (GIS) export format may also be acceptable. The specific format of the data to be provided to CDM will be specified in the SOW. It is recommended that a review of CDM client requirements be completed to determine the appropriate data format. Sufficient documentation of the digital information shall be provided to explain the data. For clarity, the surveyor will prepare the base map with groups of features on separate layers in the AutoCAD files. The CDM project manager shall designate which features will be placed on the separate layers. Tick marks indicating the latitude and longitude in the state that the work is performed shall be provided on the base map. The project manager will be responsible for ensuring that the topographic base map and digital information is completed according to CDM's drafting standards for the project.

12. In the event that aerial photographs are used, the surveyor shall field edit and statistically test the aerial topographic mapping of the site base map for conformance with the horizontal and vertical components of the National Map Accuracy Standards. The surveyor shall run random baselines throughout the site (minimum of four) to verify that less than 10 percent of horizontal and/or vertical locations exceed the values determined in the National Map Accuracy Standards. If more than 10 percent of the locations exceed the values in the National Map Accuracy Standards, then the surveyor will notify CDM.

13. Stereo map compilation by stereo photogrammetric methods will be accomplished through the use of approved stereophotogrammetric instruments using professionally recognized plotting ratios for each type of instrument. Fully trained and experienced photogrammetrists will be employed to complete stereomap compilation.

14. For broad area high precision topographic mapping, digital elevation/terrain model compilation using light detection and ranging (LiDAR) technologies is becoming more common. This method can be an efficient and effective tool for increasing engineering production at all levels. However, the error budget for a given LiDAR mapping system is dependent on the accuracy of its core subsystems (i.e., the laser rangefinder, the GPS position solution, and the inertial measurement unit [IMU]). System engineers need to balance each subsystem contribution against desired system performance (Shrestha et al. 2000).

15. The surveyor shall establish and maintain a quality control program to ensure that the survey is performed within acceptable limits. At a minimum, the surveyor will:

- Check all equipment, including compasses, transits, and levels, for accuracy and maintain records of such checks. The surveyor will make records of these checks available to CDM on request.
- Maintain and submit copies of all survey field notes.
- Field notes for each surveying activity will be kept in bound books dedicated exclusively to this project. Each book will have a table of contents. Each page of field notes shall be numbered, dated, and show the initials of all crewmembers. Black waterproof ballpoint pens will be used. Erasing is not acceptable. All errors will be crossed out with a single line and the correct data entered adjacent to the error. The crossed out and corrected data will be initialed by the party marking field notes.

16. Permits:

- The surveyor shall be responsible for obtaining any federal, state, and local permits that may be required and to perform and complete the ground surveys at the site.
- The surveyor shall not perform any work until permits (if required) are obtained.
- The surveyor shall provide separate copies of all permits to CDM before performing any onsite activities.

6.0 Restrictions/Limitations

The horizontal positions are to be surveyed within 1/10 of a foot, relative to the datum coordinate system. The vertical elevations of monitoring wells, piezometers, and staff gauges are to be surveyed within 1/100 of a foot (0.01 foot), relative to the local benchmarks. The vertical elevations of all other sampling points are to be surveyed within 1/10 of a foot, relative to the local benchmarks.

7.0 References

U. S. Department of Commerce, National Geodetic Survey (see http://www.ngs.noaa.gov).

Moffitt, F.H. and Bouchard, H. 1982. *SURVEYING* (7^{th} ed.), Harper and Row, Publishers, New York.

Shrestha, R. L. et al. 2000. *Airborne Laser Swath Mapping: Accuracy Assessment for Surveying and Mapping Applications*. University of Florida (see http://www.alsm.ufl.edu/pubs/accuracy/accuracy.htm).

TSOP 3-4

GEOPHYSICAL LOGGING, CALIBRATION, AND QUALITY CONTROL

Geophysical Logging, Calibration, and Quality Control (Includes Potential Radioactive Sites)	SOP 3-4 Revision: 5 Date: March 2007

Prepared:	Charles Callis	**Technical Review:**	Michael Valentino E-Signed by Michael C. Malloy VERIFY authenticity with ApproveIt
QA Review:	Jo Nell Mullins	**Approved:**	Signature/Date
Issued:	E-Signed by P. Michael Schwan VERIFY authenticity with ApproveIt Signature/Date		

1.0 Objective

The objective of this standard operating procedure (SOP) is to provide guidelines and define requirements for the generation of quantifiable geophysical logs of selected boreholes. The procedure defines use of a logging systems check, calibration and maintenance check, and well maintenance data documentation.

2.0 Background

Geophysical logging can be used to interpret the physical characteristics surrounding a borehole. These characteristics include the lithology, geometry, resistivity, formation resistivity factor, bulk density, porosity, permeability, structural integrity, and moisture content. Logging can also be used to evaluate well integrity and characterize vertical groundwater flow and groundwater quality within the water column. Interpretations from tool response can be used in a more quantitative fashion when the instruments used during a specific logging process are accurately and properly calibrated and operated by trained personnel. To provide consistently reliable data, a logging operator needs to ensure the following: proper tool calibration or standardization maintenance checks, a logging systems check, complete and well-maintained data documentation, and identification and protection against potential hazards.

2.1 Associated Procedures

- CDM Federal SOP 4-1, *Field Logbook Content and Control*

3.0 General Responsibilities

Site Manager - The site manager translates client requirements into technical direction of the project. The site manager plans and directs the overall project; sets technical criteria; reviews and approves technical progress; defines or approves what logs and tools are to be used after consultation with the field team leader; and considers the objectives of the project, the lithology surrounding the borehole, and the borehole conditions.

Field Team Leader - The field team leader (FTL) provides onsite supervision of the borehole logging program, administers the logging subcontractor operation, and ensures that this SOP is properly followed at all times. The FTL confers with the site manager and the logging subcontractor on what logs and tools are to be used and maintains the field logbook in accordance with CDM Federal SOP 4-1, Field Logbook Content and Control. The field team leader provides the logging subcontractor with a unique, site-specific document control or ID number for use in identifying each individual borehole or well, provides copies of checklists pertinent to the operation, and provides copies of borehole or well construction details.

Logging Subcontractor - The logging subcontractor provides equipment appropriate to the task as described in the project statement of work, provides appropriately trained and qualified personnel, and responds to administration of the FTL. The logging subcontractor ensures proper tool calibration or standardization maintenance checks, a logging systems check, complete and well-maintained data documentation, and identification and protection against potential hazards. The logging subcontractor ensures that logging subcontractor personnel read and observe requirements defined in this SOP and provides copies of their company standard and emergency operating procedures for approval by FTL before implementing any logging activities.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

4.0 Required Documentation

- Field logbook
- Appropriate log sheets (boring logs, well completion data sheets, or equivalent)
- File containing:
  a) One copy of the logging contract stating the technical requirements
  b) One approved copy of logging subcontractor SOPs and emergency operating procedures
  c) One copy of the current Nuclear Regulatory Commission (NRC) license listing certifications and approval of the type and activity level of the radioactive sources to be used onsite, if appropriate
  d) One copy of the current leak test (swipe) results of all radioactive sources containers on board the logging vehicle
  e) Physical survey forms indicating activity level at monitoring points adjacent to the radioactive source storage area of the logging vehicle
  f) Documentation of current radiation monitoring instrument calibration
  g) Documentation that all geophysical tools have been inspected and are properly operating
- Site-Specific Checklists (see attached examples)
  a) Health and Safety Checklist (Attachment 1)
  b) QA Geophysical Checklist for Borehole Logging (Attachment 2)
  c) Geophysical Logging Tool Checklist (Attachment 3)
  d) Example Log Heading (Attachment 4)

5.0 Procedures

5.1 Preparation

The site-specific health and safety plan shall be reviewed along with project plans before initiating logging activities. The logging subcontractor and the FTL or designee will confer before field activities regarding the suite of geophysical tools to be used in the operation. The FTL shall define what logs are to be used.

Considering the objectives of the logging program, the choice of tools may be further determined by the lithology surrounding the borehole and the borehole conditions. Prior logs will be used, if available, as aids to determine the appropriateness of the logging suite. These logs will be studied and serve as a baseline for the current logging activity.

Generally, fluid logs are run first within a logging suite with nuclear logs last. In uncased holes, a caliper log shall be run shortly after the fluid log, as it can yield measurements of the borehole rugosity and diameter variations useful in the onsite evaluation of uncompensated logs that may follow. Both are necessary in determining the borehole integrity and appropriateness and suitability of future logs.

The logging subcontractor shall have an approved emergency operating procedure covering all emergencies relating to tool operation, including the retrieval of a logging tool that has been lost down a hole. The logging subcontractor and FTL or designee will cooperate in determining the most suitable approach for retrieval of any tool.

Note: Some sites (such as the U. S. Department of Energy) require advance notification and approval before bringing any radiation source onto the site. This includes radioactive calibration check sources. The FTL will confirm that all site-specific requirements are met before mobilization of the logging equipment.

The following documents, certificates, and inspections will be completed by the logging subcontractor before well logging and shall be in an open, active file during logging activities.

- One copy of the current NRC license listing certifications and approval of the type and activity level of the radioactive sources to be used in the logging program.

- One copy of the current leak test (swipe) results of all radioactive sources containers on board the logging vehicle.

- Physical survey forms indicating activity level at monitoring points adjacent to the radioactive source storage area of the logging vehicle.

- Documentation of current calibration of radiation monitoring instrument.
- Copy of the logging SOP and emergency operating procedures to be followed during logging activities. Emergency procedures shall include provisions for retrieval of lost probes, with physical descriptions and drawings of the probes and head connections available at the well site.
- Documentation that all geophysical tools have been inspected and are properly operating.

Before proceeding to the field site, each geophysical logging tool will be "shop calibrated." The shop calibration (or standardization) is a method of subjecting the energized probe to a known signal level to ascertain the integrity of the logging equipment. These offsite standardization trials will be available for comparison to onsite calibration or standardization, which will be performed before and after each logging tool run. American Petroleum Institute (API) calibration scales are not usually applicable to geophysical logs made in cased holes, and log headings, in such cases, shall not exhibit environmental units or any other nonapplicable scales. Radiation logs, made through steel casing, shall display nonenvironmental "shop calibration" scale units, such as counts per second, counts per minute, or API units.

5.2 Operation

After all required equipment and material have been mobilized onsite and necessary consultations and preparations are completed, the field operations may begin. During field activities, to ensure the safety and quality of operations, a Health and Safety Checklist (Attachment 1) along with a QA Geophysical Checklist for Borehole Logging (Attachment 2) shall be completed.

Once at the site, each piece of logging equipment will go through routine standardization before and after the logging of every borehole using portable standards. All tool responses to each standard will be recorded on each borehole log trace. Personnel responsible for running the geophysical log shall perform the standardization of the logging equipment.

Calibrations and standardization will be recorded as untransformed (analog) log data (nonenvironmental units). A conversion factor or graph will accompany these data and be used to convert the raw data to environmental units. Analog to digital (A/D) conversion will be done onsite to more easily assess any problems that may arise and to implement immediate correction.

Mechanical and electrical zero response and full scale settings will be recorded and labeled as such at the beginning of each logging trace.

Before logging any borehole, the FTL or designee will review the most up-to-date information on borehole conditions such as: depth, variations in diameter, lost circulation zones, casing, debris in hole, fluid type, and known contaminants (if any) in the borehole. Each logging procedure will be determined based on assessment of borehole conditions using the most recent and previously run logs (if available).

All probe O-ring seals will be thoroughly inspected to prevent potential water leaks from developing within the instrument. Seals shall be clean and dirt free.

All logging cables need to be kink free. Logging subcontractor personnel shall be prepared to wipe or clean cables before retraction onto the storage drum.

The cable measuring sheave between the winch and well must be pre-calibrated to the currently used cable size. The sheave shall be free of any debris (e.g., dirt, ice, or dry drilling mud).

Cable heads shall be checked for electrical leaks or shorts using a volt- or ohm-meter.

Before the completion of each logging suite, a geophysical checklist will be studied and completed, where appropriate, by the FTL or designee. All checklists will be completed in black indelible ink. The Geophysical Logging Tool Checklist (Attachment 3), to be completed by the logging subcontractor equipment operator, shall indicate the specific logging tools used, order of use, and the combination of tools used concurrently. A preview of the checklist by the logging subcontractor equipment operator will serve, in part, as a reminder of potential problems that may arise during the logging run.

An example log heading, as shown in Attachment 4, shall be used. The analog trace for each log will have all pertinent information (listed below) written on the trace by the logging subcontractor equipment operator as it occurs. This may include:

- Depths per interval or division of log tracing paper
- Horizontal scale values (written at the start of each log)
- Scale changes (if done during a logging run)
- Pen positions
- Borehole/well identification
- Probe type
- Logging speed
- Tool calibration tails
- Module adjustments
- Digitized record information number

This information will be copied to a formal well log heading at the end of the logging run. Each log heading will give information relating to well and geophysical tool parameters. To interpret the well log as quantitatively as possible, it is imperative that all criteria and data entries within a log heading be filled out by the logging subcontractor equipment operator before the logging tool is removed from the cable. The completed heading will be attached to the well analog record at the well site. If required for the project, the FTL or designee may supply a unique site-specific document control or ID number written on both analog record and the log heading.

Analog and digital data records will be run as follows:

- A minimum of two independent log channels will be available to record analog data, thus permitting two traces to be recorded using different gain and baseline values. Recorder channels shall have wraparound capabilities if the trace exceeds chart span.

- The raw analog data will be converted to or recorded as a digital record onsite. Raw conversion (if required) of the analog record to digital form will allow easy data interpretation such that quick module adjustments can be made if a problem arises. The sample time and interval of the digitized record will coincide with that of the raw analog data. The digitized record will be stored on CD ROM. This will provide an onsite backup record if the original analog record is damaged or lost. The digital sample time must be predetermined before conversion and must be consistent with the onsite sample interval and time. The digitized version of the borehole record will have a document control number that will be referenced on the analog record. The analog record, in turn, will refer to the digital record label, file number, sample interval and time, and recorded depth interval. The original of records will be given to the FTL or designee. Copies shall be maintained by the logging subcontractor.

It is imperative that the logging operator continually monitor the data output of the strip chart recorder, monitor, or logging film to determine any spurious and anomalous conditions that may arise. A review of the geophysical checklist before logging will be done to prompt the logging subcontractor equipment operator of potential problems that might arise. The following briefly summarizes some of the potential problems associated with each logging technique. It shall not be a substitute for thorough training in the nuances and idiosyncrasies of specific instruments, as each tool used will have a unique circumstance that may result in a spurious log.

A. Scaling of Recording Equipment
Several problems may arise in log interpretation if horizontal and vertical scales on the strip chart recorder have not been properly set on the recorder at the beginning of the log run. While logging, repeated checks must be made to ensure readings from the depth indicator agree with chart paper divisions.

Horizontal and vertical scales need to be preset before the log run and tested within the range of expected borehole responses.

During setup time, the horizontal log scale will be written on the log paper and the depth of major chart divisions will be clearly marked as logging progresses. Knowledge of well conditions is helpful in determining the proper horizontal and vertical scale.

If during a log run the horizontal or vertical scale is determined to be insufficient and an adjustment needs to be made, it will be necessary to stop and restart the logging from the starting depth.

B. Extraneous Conditions Resulting in Anomalous Logs

The following briefly describes conditions that may give rise to anomalous log traces and shall be watched for by the logging subcontractor equipment operator.

1. **Fluid Logging**

   In newly drilled holes, it is unusual to have chemical or thermal equilibrium between the borehole fluid and surrounding borehole matrix. Consequently, fluid logs generally measure the conditions of the borehole fluid rather than borehole matrix that sometimes requires months to reach equilibrium (this would be especially true if the hole was drilled using drilling mud and development was not properly performed).

   Temperature Logs

   The introduction of fluid or air to remove drill cuttings during the drilling operation causes false temperature anomalies often requiring months to reach equilibrium. Foreign material introduced into the annulus, especially curing cement, causes anomalies not related to formation properties. For these reasons, temperature logs in recently drilled holes shall not be interpreted as formation temperature logs. Temperature logs are not easily repeated due to disturbance of the fluid during initial entry. Therefore, formation or fluid temperature logs shall be done first and recorded as the probe descends down the borehole, generally long after the well has been developed.

   Typical thermal gradients shall range between 0.47°C and 0.6°C per 30 meters (m) (100 feet) of well depth. If a log results in temperatures outside this range, extraneous effects affecting the log shall be considered. In rare instances, a log may be erroneous due to problems that arise within the probe such as thermal lag, electronic drift, and self-heating of the probe thermistor. Since these conditions are the exception and not the rule, other conditions shall be examined first as a result of questionable temperature logs.

   Log traces that result in small temperature fluctuations near the fluid surface may arise from large diameter probes descending too fast within the borehole and may not be representative of borehole conditions. Small temperature fluctuations with respect to depth may be a result of borehole conditions rather than improper tool operation. Inter-bore flow due to large head differential between aquifers can cause very small or even reversal of the thermal gradient. Fluid tracers or flow measurements may help to determine these effects.

   Convection cells within the borehole can result in temperature readings that are unrelated to the flow of water within the borehole. This is especially true for boreholes that have large diameters, fracture zones, and washouts. Consequently, the more accurate temperature logs are taken in small boreholes with small diameter probes.

   Conductivity Logs

   Conductivity logs measure the fluid conductivity within the borehole and are not always a measurement of interstitial water conductivity. Temperature drifts and movement of the probe in and out of steel casing material may give rise to sharp log deflections.

   Flow Logs

   Impeller flow-meters (commonly called spinners) are generally less sensitive than heat pulse or tracer release methods. In many aquifers, water movement is predominantly in the horizontal direction, with substantial seepage velocity variations as a function of vertical position. In these cases, knowledge of hydraulic conductivity with vertical position is essential. These conditions can be investigated best by installing the impeller flow-meter below an operating pump or in flowing artesian wells. Inter-borehole flow can often be determined by the heat pulse or tracer release methods.

2. **Caliper Logs**

   Caliper log errors shall be questioned when one of the arm traces shows no deflections. Several conditions are suspect. Heavy drilling muds, most prevalent at the bottom of the borehole, can cause failure of caliper arms to open up. Nonextended arms may be jarred open by bouncing the probe up and down or simply moving the probe to a zone with thinner muds.

Boreholes with a large degree of rugosity may give rise to peculiar log traces, especially in arm-averaging traces. For these types of holes, it is recommended that nonaveraging or a single arm caliper be used. When a single arm caliper is used, repeat logs may not be exact duplicates of one another due to potential probe rotation.

Electrical leakage and grounding problems may cause spurious trace spikes.

3. **Electrical Logging**

Spontaneous Potential (SP) Logs

Stray electrical currents caused by underground cables, lightening strikes, corroding underground pipes, and nearby electrical motors can affect SP logs, inducing spikes or a uniform cyclical response. A repeat log will need to be done shall such interferences occur.

If the logging cable has become magnetized, the log trace will consist of a cyclical sinusoidal wave that corresponds to each revolution of the cable winch. The cable shall be demagnetized and the log rerun.

Single Point Resistance Logs

Single point resistance logs are affected by electrical fields generated from underground cables. Alternating current from the underground cable becomes superimposed over the alternating current applied to the probe. This can be detected when the trace pen fluctuates when the probe is stationary. The problem can be alleviated by changing the current frequency applied to the probe electrode and double-checking while the pen is stationary.

Normal Resistivity Logs

Nearby underground cables with currents of 60 cycles per second will produce an oscillating periodic logging trace. This problem can be alleviated by changing the current frequency applied to the probe from the generator or other power source.

A logging trace that appears to be cupped, or reversed, may be the result of an electrode spacing that is greater than the formation thickness.

Induction Logs

Problems will arise if the resistivity of the formation water is fives times greater than the resistivity of the borehole fluid. As a double check, the inverse of induction measurements shall be in close agreement with formation resistivity measurements taken with other instruments.

4. **Acoustical Logging**

Acoustical televiewer (ATV) logging relies on a rotating trigger switch that is activated when a sensor passes magnetic north. Lithologic formations that are composed of magnetized material, lost drilling equipment in the borehole, and metal casing will cause the switch to malfunction. Therefore, the logging operator will need to change the trigger switch to a mechanical mechanism if they suspect the presence of magnetically susceptible materials.

Boreholes that deviate from the vertical will require careful corrections on the ATV log; these corrections shall be noted on the logging trace. If the probe is not properly centralized, dark splotches will appear on the log. This may be exacerbated when coupled with low gains.

Acoustical logs are questionable when the log trace is composed of rapid fluctuations labeled as cycle skipping. This may be a result of several conditions, such as gains that are too small or too large. For example, an amplitude that is too small will result in the first compression wave being masked by pre-arrival "noise." Skipping may also be a result of borehole fractures, solution openings, attenuating rocks, or gas in the borehole fluid.

5. **Nuclear Logging**

All nuclear logs will be run near the end of the logging suite. Borehole conditions will be carefully scrutinized for integrity and their suitability for nuclear logging during previously run logs within the logging suite. Confirmation that the borehole is suitable for nuclear logging will be between the FTL or designee and the logging operator. This will be noted on the nuclear logging checklist.

Any suspicions of potential problems arising during a nuclear log operation will be addressed immediately and resolved before further nuclear logging is carried out.

The following paragraphs briefly describe conditions that may give rise to anomalous nuclear log traces and shall be watched for by the logging operator.

Natural Gamma (Gamma Ray) Logs
The natural gamma log trace shall have maximum deflection with minimal statistical variation. Pulses of natural gamma radiation are collected and averaged over a predetermined time constant. If the time constant is too short, relative to the amplifier gain, the trace will be masked by spikes of statistical variation. If the time constant is too long, relative to the probe travel and amplifier gain, the log trace is rounded off and lacks resolution. Logging speed and time constant setting shall produce a trace with sharp anomalous peaks, with a minimum of clutter and maximum horizontal span.

Natural gamma logs are sensitive to borehole configurations and packing materials. Sudden trace deflections or changes in amplitude may be due to borehole diameter irregularities and drilling or well construction fluids; consequently, all gamma traces must be checked with a caliper trace.

Migration of water containing radioactive colloidal particles (i.e., clays or sylvite) through the borehole cracks and fissures will give traces that are not representative of the borehole matrix.

Gamma-Gamma (Gamma Density) Logs
Gamma-gamma logs are affected by borehole configuration, casing, cement, mud, probe "stand off," and background radiation. Therefore, a high resolution caliper log and background radiation check shall always be compared with the gamma-gamma log trace to differentiate whether the trace response is due to matrix porosity and density parameters or extraneous effects.

A 4-pi gamma-gamma density log, because of its capability to propagate energy in four directions, is very effective in evaluating the integrity of material placed between the well casing and borehole walls. A thorough background check is especially critical to the success of this logging technique.

Attention shall be given to sharp trace deflections. These shall be compared to other logs as they may be due to the presence of cement boundary zones, the threaded interface between casing lengths, casing nested strings, and gravel packs. In the case of the 4-pi density log, these anomalous features are the target.

Neutron Logs
Neutron logs are affected by the same borehole parameters as gamma-gamma logs (except borehole casing materials) but less dramatically. As with gamma-gamma logs, cross checks between high-resolution caliper logs, background radiation, and the neutron log shall be performed to adequately interpret the trace.

Large trace deflections will occur at the interface between fluids of different densities, such as a saline/fresh water or air/water interface.

The presence of clays and shales surrounding the borehole will give anomalously low trace responses, indicating high total porosity.

5.3 Post Operation

All checklists shown in this SOP's attachments shall be filled out before leaving the site. These checklists are designed for health and safety, quality assurance, and tool operation.

the end of each logging run (within a suite), the logging operator will complete the appropriate portions of the tool checklist. The checklist will then be verified by the FTL or designee. Any correction in data entry will be crossed out with a single line, dated, and initialed. At the end of the logging suite, each category in the checklist will have a handwritten entry. If a specific parameter does not apply, the logging operator will enter "N/A" by that category.

The original of all records will be given to the FTL or designee along with copies as may be specified. Copies of all completed checklists will also be provided.

To check for leaks, a radiation survey will be done on all nuclear probes. Shields will be checked for proper installation and defective components before probe storage. If shields of neutron sources have been found to be defective, storage before repair will be away from sodium-iodide crystals (a common component in some probe detectors) as they become radioactive when impinged upon by a neutron source.

All radioactive sources and radioactive tracers will be kept in a designated and carefully monitored storage area that has been specifically designed for storing or transporting nuclear sources. Sources stored within the facility will be sealed and placed in source holders specifically designed for their use. Each storage container will be clearly labeled with the following information: source material, concentration in Curies, and dose rate at 1 meter from the holder. Labels, warning signs, and alarms for source containers and the storage facility will follow that prescribed by the NRC. The storage facility and source containers will not be altered in any way, and both will be locked when unattended.

Each probe will be securely fixed to a stand or other similar structure where it will be cooled, cleaned, and inspected for damage. Repairs will be made when possible. If the probe cannot be repaired onsite, a note will be made of this on the tool checklist and the tool will be labeled "out of service" until repairs can be made.

The site will be checked for any debris, spills, or litter resulting from logging activities. All such matter will be removed and disposed of in accordance with regulations applicable to the site.

5.4 Cleaning and Decontamination

All equipment brought onto the site shall be clean and free of leaking oil, grease, or hydraulic fluid. Equipment that may contact the interior of the borehole shall be cleaned and decontaminated in the designated decontamination area. Downhole equipment will be: (1) steam cleaned, (2) scrubbed with a brush and laboratory-grade detergent and water solution, and (3) rinsed with potable water before its use downhole and between holes. Some downhole geophysical probes may have restrictions pertaining to decontamination and will be decontaminated according to the manufacturer's specifications.

After cleaning and decontamination, all tools and equipment that may be used downhole must be kept clean and free of contaminants. Decontaminated equipment shall be kept off the ground by storing on clean racks and/or wrapping in plastic. All tools and equipment shall be cleaned and decontaminated as required to maintain an uncontaminated condition.

6.0 Restrictions/Limitations

Several hazards are associated with activities surrounding geophysical logging and these are outlined below:

6.1 Mechanical Hazards

The use of machinery to lift and lower the probe in and out of the borehole may require the use of hoists, cables, winches, rigs, etc., that are under tension or compression. Breakage or malfunction of any one of these components could cause the release of uncontrollable forces that may in turn impart tremendous physical damage to personnel and other equipment.

Site personnel shall be aware of swinging probes (weighing up to 136 kilograms [kg] [300 pounds]), or other associated equipment, suspended in midair before entry or after exiting the borehole. Site personnel shall also guard against falling components from probes that have had joints loosened.

6.2 Electrical Hazards

Hazards may arise from the use of several electrical power sources. Potential shocks may arise from improper handling of nongrounded power supplies or from probes using induced current electrodes or high voltage generators (120 to 600 V) used to power the tools. Lines from these power sources will be connected to ground fault circuit breakers.

All generators will be grounded. All extension cords from any power source will be composed of three conductor insulated wires and will be inspected for any frays, cuts, or other damage.

6.3 Nuclear Hazards

Many geophysical logging programs rely on a suite of techniques that are collectively classified as nuclear logging. Some nuclear logging tools contain radioactive materials that serve as sources of radiation that are uniquely attenuated by the surrounding borehole matrix. Other nuclear logging tools measure ambient gamma radiation and do not use radioactive sources but require frequent calibration with radioactive materials. All permits will be kept in an open file in the logging vehicle. The use of nuclear tools needs to be preplanned and carefully thought out, monitored, and well supervised by highly trained individuals familiar with the particular logging technique and equipment. Active nuclear logging tools will be stored in shields specifically designed for each tool (passive tools do not need shielding). Monitoring equipment must be used at specified times in nuclear tool storage facilities and will be calibrated at specified intervals. Tags indicating the dates of monitor equipment calibration will be attached. Wipe test results and calibration records will be stored onsite in open files.

For the health and safety of the staff engaged in geophysical logging, all personnel working with the geophysical team will wear a Thermoluminescent Dosimeter (TLD) badge or a Radiation Exposure Film Badge as required by project, client, and/or site requirements. This badge must be worn on the top front outer garment. Exception to this rule is given to visitors and temporary assistants, who must at all times maintain a safe distance (determined by the site safety officer) between themselves and the radioactive source(s).

A radiation survey meter will be available, checked, and calibrated for operation before site transport. An up-to-date copy of the radiation survey and meter calibration will be kept on file in the logging vehicle.

The following briefly summarizes the radioactive materials used for each logging technique:

- Natural gamma logging measures the ambient gamma radiation of in situ, naturally occurring elements within the geological strata such as potassium, thorium, and uranium. Tools used to detect natural gamma radiation do not emit radiation but are calibrated with radioactive material. Calibration standards requiring a license for purchase, handling, and transport will be used only by licensed and trained individuals.

- Neutron logging requires the use of radioactive sources that emit high-energy neutrons within the logging probe, some of which also emit gamma radiation. Neutron concentrations for these probes range between a low of 10 millicuries (mCi) to a high of 5 Curies (Ci). Radioactive sources commonly used in a neutron probe are americium/beryllium mixtures. Older probes may have mixtures of beryllium and radium or beryllium and plutonium. Radium/beryllium probes have an added danger over those made of americium/beryllium in that they emit high doses of gamma radiation. Because neutron radiation is most effectively attenuated by hydrogen atoms, shields for neutron sources are composed of hydrogenous materials. Storage facilities will be monitored to assure all shields are effectively blocking neutron radiation.

- Gamma-gamma and density logs contain radioactive sources that emit gamma radiation. The radioactive source most commonly used is cesium-137, with older probes using cobalt-60 as a gamma radiation source.

7.0 References

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8.0 Attachments

Attachment 1 - Example Health and Safety Checklist
Attachment 2 - Example QA Geophysical Checklist for Borehole Logging
Attachment 3 - Example Geophysical Logging Tool Checklist
Attachment 4 - Example Log Heading

Attachment 1
Example Health And Safety Checklist

Project Name/Contract Number ______________________

Well Name and Number ______________ Location ______________

Logging Company ______________________

Suite of Logs Run ______________________

Name of Recorder ______________ Initials ______________

Date and Time ______________

General Health and Safety Checklist

Yes	No	
		All personnel working in the restricted area wearing TLD Badges or Radiation Exposure Film Badges as required?
		Restricted area properly controlled, thus preventing any unauthorized entry?
		All radioactive sources are stored in a secured, labeled, and properly shielded location?
		A copy of the operating and emergency procedures has been reviewed by logging supervisor and is on file in the field office?
		Were there any incidents that required implementation of emergency procedures? If yes, were the emergency procedures followed?
		Were storage facilities of radioactive sources posted with the proper labels?

Attachment 2
Example QA Geophysical Checklist For Borehole Logging

Project Name/Contract Number ______________________________

Well Name and Number ______________ Location ______________________

Logging Subcontractor ______________________________ Date ______________

Total Borehole Depth ________ (feet) Well Depth ________ (feet) Logger ________ (feet)

Ground Elevation ________ (feet) Permanent Datum ______________

Permanent Datum Elevation ______________________ (feet)

Suite of logs to be run: Sp _____ Temp _____ "16-64" Ris _____ SPRis _____ Ind _____

Gam Ray _____ Gam Gam _____ Caliper _____ Other _____

Name of Operator: ______________________ Date: ____________ Initials: ____________

Name of Recorder: ______________________ Date: ____________ Initials: ____________

Monitor Well Construction Materials: Casing ______________________ Screen ______________

Drilling/Construction Fluids: ______________________________________

General Quality Assurance Checks

Yes	No	
		Base map is located onsite.
		Before running the nuclear logging suite, borehole conditions were evaluated and considered suitable for such logs using information from caliper and previously run logs (e.g., depth, variations in diameter, lost circulation zones, casing, debris in hole, fluid type, and known contaminants)
		Appropriate scales have been chosen using nearby, onsite well logs. These are available for a comparison to present log readings.
		Onsite tool calibrations have been performed using calibration checks implemented before and after each log run.
		Logging scales chosen for all logging tools are appropriate for borehole conditions and required sensitivity. Off-scale logs have been rerun using scale adjustments when the offending off-scale run cannot generate an on-scale plot.
		Were there scale changes while running a log? If yes, which logs? ______________
		Scale changes, exceptional conditions, and other anomalies have been appropriately annotated on the affected logs.
		Depth control during log mergings have been checked.
		After Survey Depth Errors (ASDE) have been checked.
		Hard copies have been examined for several log runs and there is good correlation of well depth between them.
		All well log hard copies have been examined upon completion of the logging suite and good correlation exists between them.
		Borehole mud samples have been taken just before logging and mud resistivity measured.
		Optimal data acquisition has been achieved by choosing the most appropriate logging speed and time constant from test runs (when necessary) of varying speeds.
		Logging speeds for boreholes less than 2,000 feet have not exceeded 25 feet per minute. Some tools may require slower logging speeds.
		Field log headings are filled out as completely as possible. Final print log headings are completely filled out.
		The repeat length for a uniform section has not been less than 50 feet, a variable section not less than 200 feet. When possible, boreholes less than 1,000 feet have had the entire hole length repeated.
		If log quality appears questionable, attempts have been made to ascertain cause and make adjustments. If a satisfactory log cannot be obtained, note reason.

General Quality Assurance Checks (Cont.)

Yes	No	
		The specific hardware brand and model number used for data acquisition has been recorded in the field logbook. All software used for data acquisition and retrieval has been recorded in the field logbook.
		Tool manufacturer, model, and serial numbers have been noted. Tool configuration, diagrams, and manuals are available and located in the field (or logging) operation office.
		Logging subcontractor has been questioned to determine whether any tools have been modified or deviate from factory specifications. Modifications have been noted on field log checklist.
		CD ROMs have been made of the unedited, raw digital logging data and are stored in the field operation office.
		Processed, raw digital data that is in final form accompanies the final processing report.
		The final processing report has the necessary audit and audit process documentation.

Attachment 3
Example Geophysical Logging Tool Checklist

Temperature Log (This log shall be run first.)		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
___ Tool logged in fluid-filled hole? (Yes/No) ___ Calibrated onsite (optional)? (Yes/No) If no, where calibrated and date of calibration? ___ Readings appear to be of good quality, no noise. (Yes/No) If noise exists, what is this attributed to?		

Spontaneous Potential (SP) Log		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
___ Tool logged in fluid-filled hole? (Yes/No) ___ Calibration performed before logging? (Yes/No) ___ Calibration performed after logging? (Yes/No) ___ Calibration data printed and attached to log trace. ___ Sensitivity for conditions appropriate? Line has "character." (Sensitivity sediment and fluid conditions may cause lack of character.) ___ No excessive SP baseline drift. ___ Baseline shifts (if necessary) annotated on log. ___ Resistivity of borehole fluid taken and recorded on log. ___ Resistivity of interstitial water taken and recorded on log.		

Project Name/Contract Number ______________________ Date ______________________

Logging Subcontractor _______ Geophysical Logging Engineer _______ Well _______ Location ______________

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Attachment 3
Example Geophysical Logging Tool Checklist (Cont.)

Caliper (i.e., 1 arm, 3 arm?) **Log**		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
___ Calibration check performed ___ Caliper reading checked in casing, if casing is present ___ Repeat section logged or second run performed		

Gamma-Gamma (Density) Log		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
___ Hole condition good, checked by previous log runs (do not run nuclear tools under questionable hole conditions) ___ Tool logged in fluid-filled or air-filled (circle one), uncased or cased (circle one) hole ___ Radiation survey conducted in immediate vicinity of drill site before unshielding source ___ Radiation survey conducted in immediate vicinity of drill site after last nuclear source is shielded and logging job is finished ___ Calibration performed before logging ___ Calibration performed after logging ___ Calibration data printed and attached to log trace ___ Log checked for anomalous spikes, drift, and cyclic readings ___ Compare density log to caliper log; density shall show a variant reading in area of washouts ___ With probe sitting still, statistical variation shall be on the order of the square root of the count rate		

Project Name/Contract Number ______________________ Date ______________________

Logging Subcontractor _______ Geophysical Logging Engineer _______ Well _______ Location _______________

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Attachment 3
Example Geophysical Logging Tool Checklist (Cont.)

Normal Resistivity	Spacing between electrodes (inches)	
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	

___ Tool logged in fluid-filled hole, uncased hole
___ Calibration performed before logging
___ Calibration performed after logging
___ Calibration data printed and attached to log trace
___ Curve is stable, with no abnormal looking excursions

Single Point Resistance		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	

___ Tool logged in fluid-filled, uncased hole
___ Calibration performed before logging
___ Calibration performed after logging
___ Calibration data printed and attached to log trace
___ Resistance greater than cable line resistance
___ Scale reads in ohms
___ Check for sharp deflections of consistent amplitude and frequency caused by mechanical problems
___ Compare to caliper log. Is log greatly affected by change in borehole diameter?

Project Name/Contract Number ______________________ Date ______________________

Logging Subcontractor _______ Geophysical Logging Engineer _______ Well _______ Location ______________
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Attachment 3
Example Geophysical Logging Tool Checklist (Cont.)

Induction	Spacing between electrodes (inches)	
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	

___ Tool logged in fluid-filled or air-filled (circle one), uncased hole
___ Calibration performed before logging
___ Calibration performed after logging
___ Calibration data printed and attached to log trace
___ Check for negative resistivity readings for indication of improper calibration
___ Check for similarity to 16" normal resistivity curve, for single curve, shallow investigation induction log
___ Repeat section logged

Natural Gamma (Gamma Ray) Log		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	

___ Tool logged in fluid-filled or air-filled (circle one), uncased or cased (circle one)
___ Radiation survey conducted in immediate vicinity of drill site before unshielding source
___ Radiation survey conducted in immediate vicinity of drill site after last nuclear source is shielded after job is finished
___ Hole condition is shielded after job is finished
___ Hole condition good, checked by previous log runs; do not run nuclear tools under questionable hole conditions
___ Tool run in fluid-filled or air-filled (circle one), uncased or cased (circle one)
___ Calibration performed before logging
___ Calibration performed after logging
___ Calibration data printed and attached to log trace
___ Check for cyclic noise
___ Repeat section logging

Project Name/Contract Number ______________________ Date ______________________

Logging Subcontractor _______ Geophysical Logging Engineer _______ Well _______ Location _______________

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Attachment 3
Example Geophysical Logging Tool Checklist (Cont.)

Neutron	Spacing between electrodes (inches)	
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	

__ Hole condition good, checked by previous log runs (do not run nuclear tools under questionable hole conditions)
__ Tool logged in fluid-filled or air-filled (circle one), uncased or cased (circle one) hole
__ Radiation survey conducted in immediate vicinity of drill site before unshielding source
__ Radiation survey conducted in immediate vicinity of drill site after last nuclear source is shielded after logging job is finished
__ Calibration performed before logging
__ Calibration performed after logging
__ Calibration data printed and attached to log trace
__ Check log for adequate sensitivity
__ Check log for anomalous spikes, drifts, and cyclic readings
__ Repeat section logged

Acoustic Logs		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	

__ Tool logged in fluid-filled, uncased hole (yes/no). If no, explain.
__ Calibration not required; check tool for function by listening for transmitter clicking; may calibrate tool in fluid-filled surface casing if present
__ Tool centralized
__ Log checked for noise spikes, cycle skipping, or other anomalies
__ Repeat section logged

Project Name/Contract Number ______________________________ Date ______________________________

Logging Subcontractor _______ Geophysical Logging Engineer _______ Well _______ Location ________________

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Attachment 4
Example Log Heading

<table>
<tr><td colspan="3">Logging Subcontractor:</td><td colspan="3">Log Technique:</td></tr>
<tr><td colspan="3">Address:</td><td colspan="3">Date:</td></tr>
<tr><td colspan="6">Logging Operator:</td></tr>
<tr><td colspan="6">Drilling Subcontractor:</td></tr>
<tr><td colspan="6">Client:</td></tr>
<tr><td colspan="6">Well:</td></tr>
<tr><td colspan="6">Location:</td></tr>
<tr><td colspan="3">State:</td><td colspan="3">Ground Elevation (m) (ft):
Log Depth Ref:</td></tr>
<tr><td colspan="6">Borehole Data</td></tr>
<tr><td colspan="6">Logging Depth:</td></tr>
<tr><td colspan="3">Customer Measurement (m) (ft):</td><td colspan="3">Logging Subcontractor Measurement (m) (ft):</td></tr>
<tr><td colspan="3">Bit Record</td><td colspan="3">Casing Record</td></tr>
<tr><td>Size</td><td>From</td><td>To</td><td>Size/Wgt/TLK</td><td>From</td><td>To</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Hole Medium:</td><td colspan="2"></td><td colspan="2">Drilling Method:</td></tr>
<tr><td colspan="2">Borehole Mud:</td><td colspan="2"></td><td colspan="2">Circulation Time:</td></tr>
<tr><td colspan="2">Weight:</td><td colspan="2">Viscosity:</td><td colspan="2">Restrictions:
mud formation
at Temperature:</td></tr>
</table>

Project Name/Contract Number ______________________ Date ______________________

Logging Subcontractor _____ Geophysical Logging Engineer _____ Well _____ Location __________

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Attachment 4
Example Log Heading (Cont.)

Logging Data						
Log Function	Run No.	Equipment			Logging	
		Model	Probe No.	Uphole S.N.	Dig Int (m/ft)	Speed (m/min)(ft/min)

Logging Data							
Detect OR	Spacing		Source		Logged Interval		
Type	Tx-Rx (m/ft)	Rx-Rx	Type	Curie Amount	From	To	Int. (m/ft)

Project Name/Contract Number ______________________ Date ______________________

Logging Subcontractor _______ Geophysical Logging Engineer _______ Well _______ Location ______________

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TSOP 3-5

LITHOLOGIC LOGGING

LITHOLOGIC LOGGING

Prepared: Del R. Baird

Technical Review: Ken Black

QA Review: David O. Johnson

Approved: [signature] 2/23/99
Signature/Date

Issued: Rose Mary Gustin 2/24/99
Signature/Date

1.0 OBJECTIVE

This standard operating procedure (SOP) governs lithologic logging of core, cuttings, split spoon samples, and subsurface samples collected during field operations at sites where environmental investigations are performed by CDM Federal Programs Corporation (CDM Federal). The purpose of this SOP is to present a set of descriptive protocols and standardized reporting formats to be used by all investigators in making lithologic observations. It prescribes protocols for recording basic lithologic data including, but not limited to, lithologic names, texture, composition, color, sedimentary structures, bedding, lateral and vertical contacts, and secondary features such as fractures and bioturbation.

The goal of this SOP is to provide a set of instructions to produce uniform lithologic descriptions and to present a list of references to help in this task.

2.0 BACKGROUND

2.1 Definitions

The following list of definitions corresponds to the description sequences outlined in Section 5.2.1. They are provided to aid the lithologic logger in what to look for when following the sequences. An example lithologic log is given in Attachment A.

Name of Sediment or Rock - In naming unconsolidated sediments, the logger should use field equipment and reference charts to help identify the grain-size distribution and should name the material according to the procedure in Section 5.2.1. In naming sedimentary, igneous, and metamorphic rocks, the logger should examine the specimen for mineralogy and use the appropriate classification chart in the attachments.

Texture - In examining unconsolidated sediments, the texture shall refer to the grain size distribution, particle angularity, sorting, and packing. The logger should provide estimates of the grain-sizes present using Attachment B and C. When larger particles such as cobbles are present, determine the size of the particles and give a percentage estimate. The sediment particles should be examined for angularity by comparing with Attachment B and the sorting should be determined by percentage estimation. The logger should note that the USCS classification system uses the term grading to describe how the materials are sorted. (A poorly sorted unconsolidated material is well graded.) In examining igneous rocks, texture refers to whether the specimen is aphanitic, phaneritic, glassy, fragmental, porphyritic, or pegmatitic. Attachment D has more specific definitions of these terms. For metamorphic rocks, texture refers to whether the specimen has a foliate structure (slately, phillytic, schistise, or gneissic) or non-foliate structure (granular).

Color - Color may be determined using the appropriate Munsell color chart (soil or rock) and listing the Munsell number that corresponds to the color. If an unconsolidated material is mottled in color, the ranges in color should be described. When describing core samples with several individual colors such as in phaneritic textures, individual color names should be listed and an overall best color name should be given.

Sedimentary Structures - This term refers primarily to unconsolidated sediments and sedimentary rocks. There are several different sedimentary structures and the logger is referred to Compton's Manual of Field Geology (1962) book for more details. Among the more common structures are bedding, cross bedding, laminations, and burrows. These structures should only be included in the description if found in the samples.

Degree of Consolidation - The degree of consolidation is applicable to sedimentary rocks and unconsolidated sediments and refers to how well the material has been indurated. Unconsolidated sediments may be compacted somewhat and should be described as loose, moderately compacted, or strongly compacted. In some cases they may be slightly cemented by caleche and should be described as slightly cemented, moderately cemented, or strongly cemented. Sedimentary rocks are typically indurated but may vary in the degree of cementation. These materials should be described as friable, moderately friable, or well indurated. When describing the cementing material, a test for reaction to hydrochloric acid (HCl) should be done and results recorded under the description. If the logger believes he/she can identify the cementing material then it should be included in the description.

Moisture Content - Moisture content refers to the amount of water within the sediment or the matrix. Typically sedimentary rocks and unconsolidated sediments may have water within and should be described as dry, moist, or wet. Igneous and metamorphic rocks may have water within fractures and cavities. The presence of water and pertinent observations that may help in site evaluation in these rocks should be noted.

Presence of Fractures, Cavities, and Secondary Mineralization - The rock types that may be encountered during drilling may have fractures or joints present within them. Should fractures be observed, they should be noted and a description as to the density of fractures should be given. Cavities or vugs may be present and the density of voids as well as a size estimation should be given. If fractures or cavities contain evidence of secondary minerals such as zeolites, clays, or iron oxides, then a description of the mineral fill should be added.

Evidence of Contamination - The logger should examine the core and note any obvious signs of contamination such as streaking, free product, odor, or discoloration. These observations should be noted in the field book as should any readings from the photo ionization or flame ionization detector (PID/FID). PID/FID hits should be recorded on the Lithologic Log form also.

Description of Contacts - The logger should note any significant change in lithology. These changes may be gradational contacts within sediments or may be sharp contacts such as sediments over rocks. The contacts should be noted as to whether they are erosional, gradational, or sharp and the depth below the surface should be noted.

Composition - The composition of the rock refers to the mineralogy of the material encountered. For sedimentary rocks, it is important to note the matrix composition and use Attachment E in naming. In igneous and metamorphic rocks, the minerals that make up the rock should be stated and an estimation of their percentage should be noted. The classification charts listed in the Attachments D and F provide a description of common compositions.

Degree of Vitrification - This term is applicable to volcanic rocks and refers to the degree of welding in pyroclastic materials. Describe these rocks as poorly welded, moderately welded, or strongly welded.

2.2 Discussion

The installation of monitoring wells, piezometers, and boreholes is a standard practice at many sites requiring environmental investigations. The installation of these devices requires that a trained geologist, or other earth scientist, provide lithologic descriptions as they encounter subsurface material during auguring or drilling. In evaluating these lithologic descriptions from different boreholes, monitoring wells, or piezometers, it is sometimes possible to correlate similar units. To help in this task, it is important to provide uniform and consistent descriptions.

In describing lithologies, it is helpful to have a set of references covering items such as the classification of igneous, metamorphic, and sedimentary rocks, grain-size percentage estimation, particle shape, grain-size charts, and lithologic symbols. In order to make lithologic descriptions produced by CDM Federal staff as uniform and consistent as possible, this SOP provides a list of references to be used in the field. This SOP also provides a sequence for recording information on a standardized log form to make descriptions as uniform and consistent as possible.

3.0 RESPONSIBILITIES

Geologist - The field person performing lithologic logging is responsible for making a consistent and uniform log and for turning in field forms and logbooks to the Field Team Leader (FTL).

Field Team Leader - The FTL is responsible for maintaining logbooks and forms and for approving techniques of lithologic logging not specifically described in this SOP.

4.0 REQUIRED EQUIPMENT

The description of subsurface lithologies requires a minor amount of field equipment for the geologist. This section provides a list of equipment to be used by the lithologic logger but does not include equipment such as drill rigs, PID/FID, sampling equipment, and personal protection equipment. The following is a general list of equipment that may be used:

- Field logbook and Lithologic Log form
- Clipboard
- Dilute (10%) HCl
- Plastic sheeting
- PVC sampling trays
- Waterproof pens
- No. 2 sieve
- 10x magnifying hand lens
- Reference field charts
- PID/FID

5.0 PROCEDURES

5.1 Office

- Obtain field logbook and Lithologic Log forms
- Coordinate schedules/actions with FTL
- Obtain necessary field equipment (i.e., hand lens, 10% HCl)
- Obtain CDM Federal reference field charts
- Review field support documents (i.e., sampling plan, health and safety plan)

- Review applicable geologic references such as U.S. Department of Agriculture (USDA) Soil Conservation Survey Soil Surveys and/or geologic maps

5.1.1 Documentation

Individuals performing lithologic logging will record their observations in a commercially available, bound field logbook (e.g., Lietz books) and/or on individual Lithologic Log forms. Lithologic loggers will follow the general procedures for keeping a field logbook. When using a bound field logbook, record the same data required on the Lithologic Log form. Data from the field logbook must be transcribed to the Lithologic Log form if filling in the form in the field is not feasible. However, the data must be the same as that recorded in the field logbook. Editing of field logbook data is not allowed. In addition, if data are transcribed to the Lithologic Log form, it should be done within one day of the original data recording. All blanks in the Lithologic Log form must be filled out. If an item is not applicable, an "NA" should be entered.

The Lithologic Log form should be filled out according to the following instructions:

The top part of the form contains general information. The project name and number must be filled in to identify the site. The date that drilling was started and completed, and the well number within the site should be stated. The name of the person logging the well is recorded as is the total depth drilled. Weather condition descriptions should correlate with what is written in the logbook. The last item to be completed is the name and company of the driller and the type of drill rig and bits used.

The bottom part of the form shall be completed according to the instructions provided within this section and according to the sequence provided in Section 5.2.1. The depth column refers to the depth below ground surface and should be provided in feet. The tick marks can be arbitrarily set to any depth interval depending on the scale needed except where client requirements dictate the spacing. The lithology column should contain a schematic representation of the subsurface according to the symbols found in Attachment G. Use a single X to mark the area where no core was recovered, and notes should be recorded as to why the section was not recovered. The X should be marked from the top to the bottom of the section so that the entire interval is marked. If the geologist can interpret the probable lithology of the missing section with reasonable confidence, they may fill in the symbols behind the X. Sharp or abrupt contacts between lithologies will be indicated by a solid horizontal line. Gradational changes in lithologic composition will be shown by a gradual change of lithologic symbol in the appropriate zone. PID/FID hits should be recorded within the PID/FID column at the appropriate depth, if applicable. Blow counts specifically refer to the number of hammer blows it takes to drive a split spoon into the ground. Usually this is recorded as the number of blows per 6 inches but may vary. The recording of blow counts provides a relative feel for the cohesiveness of the formation. The individual recording lithologic logs should ask the FTL whether it is required information. The description column is the most important part of the lithologic log form and is where the lithology is described. In completing this section, use the applicable reference charts and complete according to the sequence in Section 5.2.1. The sample interval column is reserved for noting any samples taken and processed for the laboratory. The sample number shall be filled in at the appropriate depth. The last column refers to the percent core recovery. The individual performing lithologic logging should determine the amount recovered and write the percentage at the appropriate depth.

In addition to the information on the lithologic form, the logger should fill in appropriate information into the logbook when there is a rig shut down, rig problems, failures to recover cores, or other issues.

5.2 General Guidelines for Using and Supplementing Lithologic Descriptive Protocols

This SOP is intended to serve as a guide for recording basic lithologic information with emphasis on those sediment or rock properties that affect groundwater flow and contaminant transport. The fields of specialization of geologists using this SOP will vary. If the user has expertise in a particular field of petrology or soil science that allows for descriptions of certain geologic sections beyond the basic level required by this SOP, they may expand their descriptions. This should be done only with approval of the FTL. The descriptive protocol presented here must be followed in making basic observations. Any further descriptions must follow a protocol that is published and generally recognized by the geologic community as a standard reference. General lithologic description will not include collecting detailed information such as can be obtained from sieve analysis or petrographic analysis. This SOP is a guide for recording visual observations of samples in the field aided by a 10x hand lens and the other simple tools. Field descriptions should be supplemented by petrographic analysis and sieve analysis when the FTL needs data on numerical grain size distributions, secondary porosity development, or other data that can be collected by these methods.

This SOP includes protocols for describing igneous, metamorphic, sedimentary rocks, and unconsolidated materials. Common abbreviations are given in Attachment H. This SOP includes charts to be used for classification and naming of rocks, sediments, and soils, and descriptions of texture, sedimentary structures, and percentage composition of grains. There is also a chart of lithologic symbols to be used and a list of abbreviations. For charts covering other observations or field procedures not specified by this SOP, the user is referred to the following for more information:

- *Compton's Manual of Field Geology* and *American Geological Society (AGI) Data Sheets for Geology in the Field, Laboratory, and Office* contain other reference charts applicable to descriptions. The source of the chart used must be recorded on the Lithologic Log form or in the field logbook.

- The Munsell soil color chart may be used for descriptions of color.
- The Dictionary of Geological Terms (AGI) is to be used for definitions of geological terms.

Some observations will be common to all rock and soil descriptions. All descriptions should include as appropriate: name of sediment or rock, color, sedimentary structures, texture, moisture content, composition, fabric, significant inclusions, and degree of consolidation or induration. The description of each category should be separated by a semicolon. Each section that discusses descriptions of a particular lithology provides a sequence for recording observations. Follow these sequences for all descriptions. All lithologic descriptions shall be segregated from interpretive comments by recording them in the field book.

Secondary features affecting porosity and permeability such as fractures (joints or faults), cavities, and/or bioturbation should be described if observed. Exact measurement of apparent bed thicknesses should be made when logging core and should supplement terminology such as "thin" or "thick." Particular attention is to be given to recording exact locations of water tables, perched saturated zones, and description of contaminants that may be visible. In some cases individuals logging may wish to describe materials such as unconsolidated sediments and soils according to different systems such as the Unified Soil Classification System (USCS) or USDA Soil Taxonomy System. These descriptions can provide additional information from what is required by this SOP. If an individual is competent in using other description methods, then they should do so with permission from the FTL. It is often more practical to use abbreviations for often repeated terminology when recording lithologic descriptions. For the terms given in this SOP, its Attachments, or the associated charts to be used for description in the field, use only the designated abbreviations. Other abbreviations are allowed. However, the abbreviation and its meaning should be recorded on the lithologic log the first time it is used and should be recorded at least once for every well or boring log. Loggers are cautioned to limit the use of abbreviations to avoid producing a lithologic log that is excessively cryptic.

5.2.1 Protocols for Lithologic Description

This section describes the protocols for completing a lithologic description. The logger should use the appropriate portion of this section when describing cores. In recording descriptions of sedimentary sections from a whole core it is possible to reduce the amount of description being written by at least two strategies. One is to look at as long of a section of core as possible, looking for the "big" picture. For instance, in a 20-ft-thick zone the dominant lithology may be siltstone that is interrupted by several thin beds of another lithology such as gravel. This section description can be simplified by writing: 35-55 (below ground surface) bgs = siltstone (with other descriptors) except as noted; 37.5-38.5 gravel zone (with descriptors); 40-42 pebble zone (with descriptors); etc. This also aids in "seeing" the thickest unit designations possible for use in modeling. Another acceptable way to describe the same interval would be: 35-37.5 siltstone; 37.5-38.5 gravel zone (with descriptors); 38-40 same as 35-37.5; 40-42 pebble zone (with descriptors); etc.

Description of Unconsolidated Material

Unconsolidated material comprises a significant portion of the sections of interest at CDM Federal sites. The shallow subsurface is very important to the hydrologic investigation, as this is the portion of the geologic section where infiltration first occurs. Much of the contamination at sites being investigated is surface contamination and therefore lies on, or within, the upper portion of the surficial material.

For the purpose of this SOP, soil refers to the upper biochemically weathered portion of the regolith and not the entire regolith itself. Soils are to be described as unconsolidated material and should use the same description format. The scientist may use the USCS classification if consistent with project objectives. More detailed soil descriptions should only be made in addition to descriptions outlined in Section 3.3.3.

Descriptions of unconsolidated sediments should follow the following sequence:

Name of sediment (sand, silt, clay, etc.)
- Texture
- Composition of larger-grained sediments
- Color
- Structure
- Degree of consolidation and cementation
- Moisture content
- Evidence of bioturbation
- Description of contacts

In naming unconsolidated material (refer to Naming of Unconsolidated Materials, Attachment I), the particle size with the highest percentage is the root name. When additional grains are present in excess of 15%, the root name is modified by adding a term in front of the root name. For instance, if a material is 80% sand and 20% gravel, then it is gravelly sand. If the subordinate grains comprise less than 15% but greater than 5%, the name is written: ____________________(dominant grain) with ________________(subordinate grain). For example, a sediment with 90% sand and 10% silt would be named a sand with silt. If a sediment contains greater than 15% of four particle sizes, then the name is comprised of the dominant grain size as the root name and modifiers as added before. For example, if a material is 60% sand, 20% silt and 20% clay the name would be a silty clayey sand. If a material is 70% sand, 20% silt and 10% clay, it would be a silty sand with clay. When large cobbles or boulders are present, their percentage should be estimated and their mineralogy recorded. Use AGI Data Sheet 29.1 (Attachment B) for grain terms. Refer to Attachment J for an example sorting chart.

Description of Sedimentary Rocks

Sedimentary rocks consist of lithified detrital sediments such as sand and clay, chemically precipitated sediments such as limestone and gypsum, and biogenic material such as coal and coquina. The classification scheme for naming these rocks is found in Attachment E, Classification of Sedimentary Rocks.

Descriptors for sedimentary rocks should be given in the lithologic log in the following sequence:

- Name of rock
- Texture
- Color
- Sedimentary structures
- Degree of composition
- Presence of fractures or vugs
- Moisture content
- Bioturbation
- Description of contacts

Description of Igneous and Metamorphic Rocks

Igneous rocks, volcanic and plutonic, and metamorphic rocks are not as commonly observed at work sites, but they may be found interspersed in the sedimentary section as ash layers and as bedrock. Where they form bedrock, the development of fractures and vugs is important to their hydrologic properties. If the logger is unsure of the name of the rock because of difficulty in determining mineralogy, the name shall be accompanied by a question mark. Attachments E and F provide a classification system for these materials.

Igneous and metamorphic rock descriptions should follow the general format:

- Name of rock
- Texture
- Color
- Degree of induration for volcaniclastics
- Composition
- Presence of fractures or vugs
- Presence of secondary mineralization

- Moisture content
- Weathering

6.0 RESTRICTIONS/LIMITATIONS

Only geologists, or similarly qualified persons trained in lithologic description are qualified to perform the duties described in this SOP. The FTL for a project will have the authority to decide whether or not an individual is qualified.

7.0 REFERENCES

American Geological Society, *American Geological Society Data Sheets for Geology in the Field*, Laboratory, and Office, 3rd Ed, 1989.

American Geological Society, *Dictionary of Geologic Terms*, Anchor Press, Garden City, New York, 1960.

Compton, R.R., *Manual of Field Geology*, John Wiley & Sons Inc., New York, New York, 1962.

Munsell Color Chart, Soil Test Inc., Evanston, Illinois, 1975.

U.S. Department of Agriculture Soil Conservation Service, *Soil Taxonomy*, U.S. Government Printing Office, Washington, D.C., 1972.

Woodward, L.A., *Laboratory Manual Physical Geology*, University of New Mexico Printing, Albuquerque, New Mexico, 1988.

8.0 ATTACHMENTS

Note: These Attachments are for informational purposes. Other equivalent charts such as USCS or logs may be used.

Attachment A - CDM Federal Programs Corporation Lithologic Log

Attachment B - Grain-size Scale, Graph determining size of sedimentary particles, particle degree of roundness charts.

Attachment C - Particle degree of Distribution Estimation Chart

Attachment D - Classification of Igneous Rocks

Attachment E - Classification of Sedimentary Rocks

Attachment F - Classification of Metamorphic Rocks

Attachment G - Lithologic Symbol Chart

Attachment H - Abbreviations

Attachment I - Naming of Unconsolidated Materials

Attachment J - Sorting Chart

Attachment K - Example of United Soil Classification System (USCS)

ATTACHMENT A

CDM FEDERAL PROGRAMS CORPORATION
LITHOLOGIC LOG

Boring No. ______		Sheet ____ of ____
Project:	Project No.:	Date Started:
Well No.:	Rig:	Date Ended:
Logged by:	Total Depth:	Driller:
Weather:		Bits:

DEPTH	LITHOLOGY	SAMPLE INTERVAL	% RECOVERY	PID/ FID	BLOW COUNTS	DESCRIPTION

PROPORTIONS	COHESIONLESS	COHESIVE CONSISTENCY
	Blows	Blows
trace 0 to 10%	loose 0 to 10	0-4 soft
little 10 to 20%	med dens 10 to 30	4-8 med stiff
some 20 to 35%	dense 30 to 50	8-15 stiff
and 35 to 50%	very dense 50+	15-30 very stiff
		30+ hard

ATTACHMENT B

AGI DATA SHEET 29.1

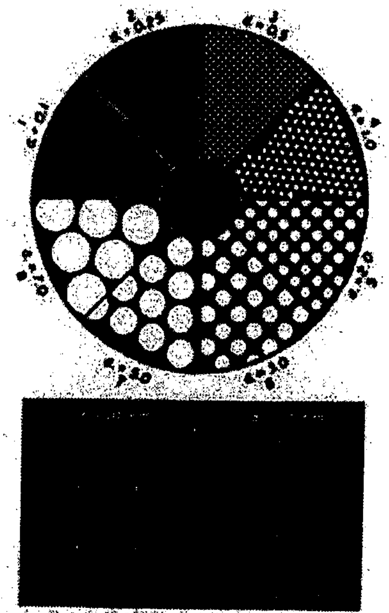
Grain-size Scales

By Roy L. Ingram, University of North Carolina
GRAIN-SIZE SCALE USED BY AMERICAN GEOLOGISTS
Modified Wentworth Scale — after Lane, et al., 1947, Trans. American Geophysical Union, v. 28, p. 936-938

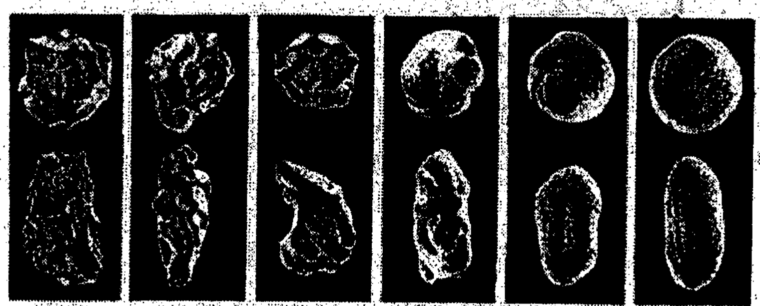
phi	mm		inches	U.S. Standard Sieve Series	Grade Name		
−12	4096		161.3				
					very large		
−11	2048		80.6				
					large		
−10	1024		40.3			Boulders	
					medium		
−9	512		20.2				
					small		
−8	256		10.1				
					large		
−7	128		5.0			Cobbles	GRAVEL
					small		
−6	64		2.52	63 mm			
					very coarse		
−5	32		1.26	31.5 mm			
					coarse		
−4	16		0.63	16 mm		Pebbles	
					medium		
−3	8		0.32	8 mm			
					fine		
−2	4		0.16	No. 5			
					very fine		
−1	2		0.08	No. 10			
					very coarse		
0	1		0.04	No. 18			
					coarse		
+1	1/2	0.500		No. 35			
					medium	Sand	SAND
+2	1/4	0.250		No. 60			
					fine		
+3	1/8	0.125		No. 120			
					very fine		
+4	1/16	0.062		No. 230			
					coarse		
+5	1/32	0.031					
					medium		
+6	1/64	0.016				Silt	
					fine		
+7	1/128	0.008					
					very fine		
+8	1/256	0.004					MUD
					coarse		
+9	1/512	0.002					
					medium		
+10	1/1024	0.001				Clay size	
					fine		
+11	1/2048	0.0005					
					very fine		
+12	1/4096	0.00024					

AGI DATA SHEET 29.2

LIGHT PARTICLES



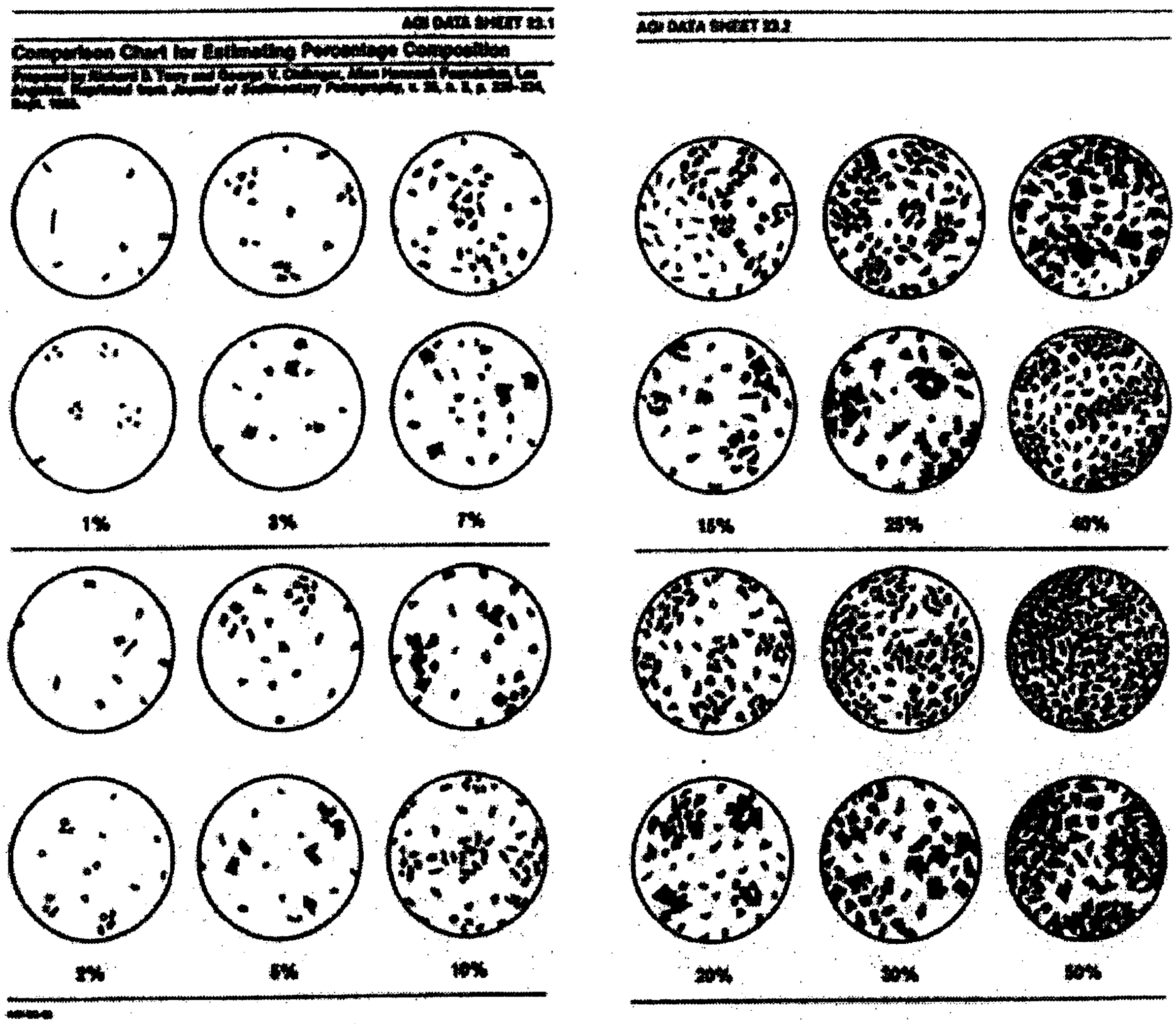
American Geological Institute, Data Sheets, Third Edition, 1989.



Very angular — Angular — Sub-angular — Sub-rounded — Rounded — Well rounded

Compton, R.R., Manual of Field Geology, 1962.

ATTACHMENT C



American Geological Institute, Data Sheets, Third Edition, 1989.

ATTACHMENT D

<table>
<tr><th colspan="6">CLASSIFICATION OF IGNEOUS ROCKS</th></tr>
<tr><th colspan="6">MINERAL COMPOSITION</th></tr>
<tr><td colspan="2"></td><td>Quartz >10%
Abundant feldspar
Mafic minerals minor</td><td>Quartz <10%
Abundant feldspar
Mafic minerals moderate</td><td>Feldspar abundant Mafic Minerals 40-70%; Quartz minor or absent</td><td>Mafic minerals >70%</td></tr>
<tr><td colspan="2">Color Index</td><td>Light Color</td><td>Intermediate color</td><td>Dark</td><td>Dark</td></tr>
<tr><td colspan="2">Chemistry</td><td>SiO_2 70%</td><td>SiO_2 60%</td><td>SiO_2 50%</td><td>SiO_2 40%</td></tr>
<tr><td rowspan="5">T
E
X
T
U
R
E</td><td>Phaneritic (visible with naked eye)</td><td>Granite (Gr)</td><td>Diorite (Dr)</td><td>Gabbro (Gb)</td><td>Peridotite (Pr)
(mostly olivine)</td></tr>
<tr><td rowspan="2">Aphanitic
(microscopic)</td><td>Rhyolite (Ry)
(quartz phenocrysts)</td><td>Andesite (An)
(feldspar or mafic phenocrysts; no quartz)</td><td rowspan="2">Basalt (Ba)</td><td rowspan="4">Komatiite (Km)
(very rare)</td></tr>
<tr><td colspan="2">Felsite (Fl)
(no phenocrysts)</td></tr>
<tr><td>Glassy</td><td colspan="2">Obsidian (ob) Pumice (Pu)</td><td>Rare</td></tr>
<tr><td>Glassy-Fragmental
(Pyroclastic)</td><td colspan="2">Tuff <4mm (Tf)
Breccia >4mm (Br)</td><td>Rare</td></tr>
</table>

* modified from Woodward, L. A., Laboratory Manual Physical Geology, 1988.

ATTACHMENT E

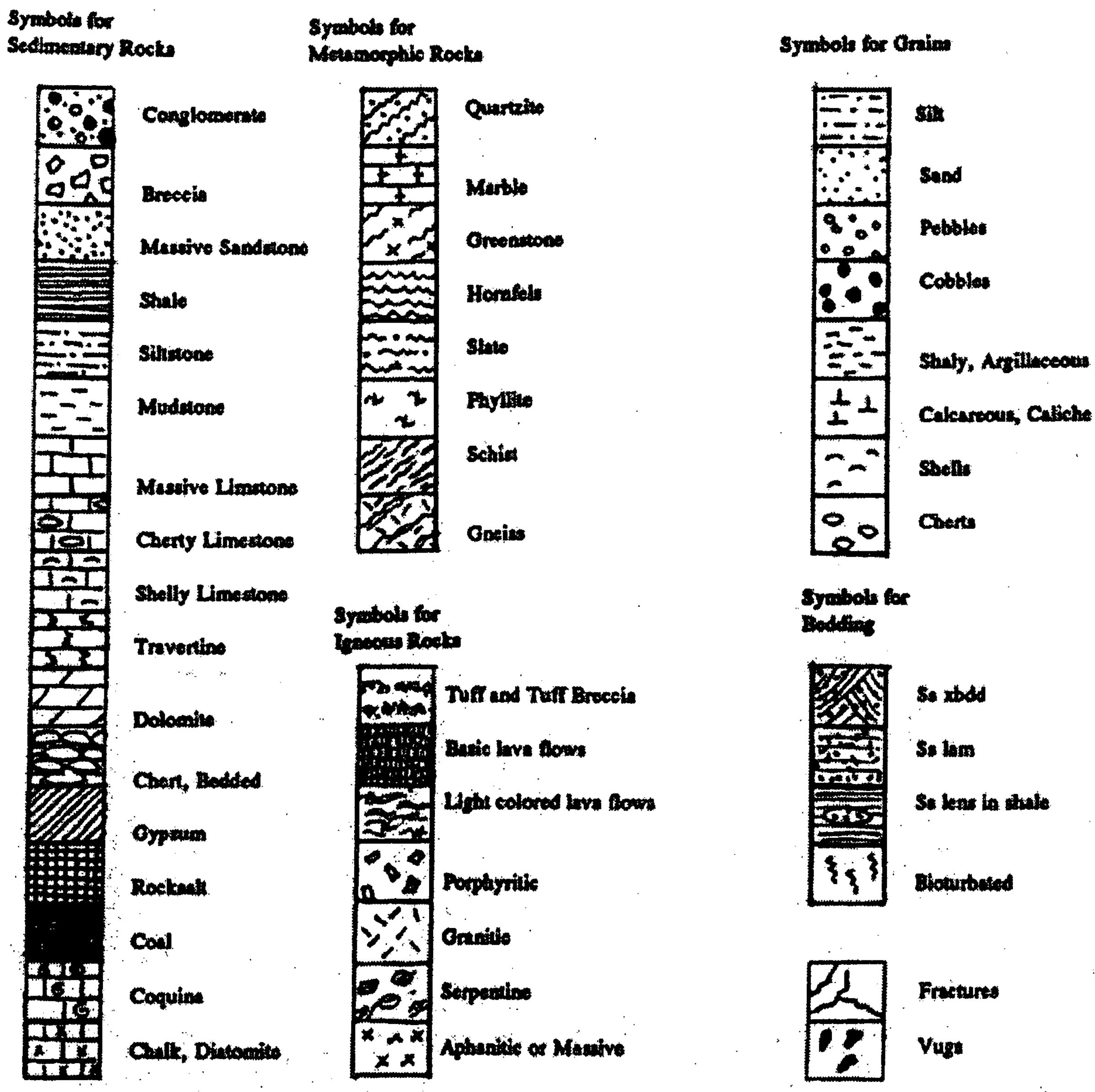
CLASSIFICATION OF SEDIMENTARY ROCKS		
	COMPOSITION AND/OR GRAIN SIZE	NAME OF ROCK
DETRITAL	Gravel greater than 2 mm	CONGLOMERATE (Cg)
		BRECCIA (Br)
	Sand 2 mm to 1/16 mm	SANDSTONE (Sa) QUARTZ (Qrz) GRAYWACKE (Gw) ARKOSE (Ak)
	Mud less than 1/16 mm	SHALE (Shl)
		SILTSTONE (Sls)
		MUDSTONE (Ms)
CHEMICAL	Limy mud or oolites	LIMESTONE (La)
		TRAVERTINE (Tvr)
		DOLOMITE (Dl)
	Silica	CHERT (Ch)
	Calcium Sulphate plus Water	GYPSUM (Gy)
	Halite	ROCKSALT (Na)
BIOGENIC	Plant remains	COAL (Cl)
	Shell fragments, shells, fragments; some limy mud usually present	COQUINA (Cq)
		CHALK (Chk)
	Shells of diatoms (marine or freshwater algae)	DIATOMITE (Dm)

ATTACHMENT F

CLASSIFICATION OF METAMORPHIC ROCKS			
STRUCTURE	TEXTURE	CHIEF MINERALS	NAME
Nonfoliate	granular; breaks across grains	quartz	Quartzite (Qzt)
	granular; grains clearly visible	calcite	Marble (Mbl)
	granular; grains altered and indistinct	plagioclase; chlorite, epidote hornblende	Greenstone (Grs)
	very fine-grained	indistinguishable; mostly submicroscopic micas and clays	Hornfels (Hnf)
Foliate	slaty	submicroscopic mica, quartz	Slate (Slt)
	phyllitic	microscopic mica, quartz	Phyllite (Pyl)
	schistose	microscopic mica, quartz, amphibole	Blueschist
		chlorite, mica plagioclase	chlorite schist (CL-Sch)
		muscovite, quartz	Muscovite (Ms) Schist (Sch)
		garnet, muscovite	Garnet (G) Muscovite (Ms) Schist (Sch)
		hornblende, plagioclase	Amphibolite (Amp)
		staurolite, garnet, muscovite	Garnet (G) Staurolite (S) Muscovite (Ms) Schist (Sch)
	gneissose	plagioclase, hornblende	Amphibolite (Amp) Gneiss (Gns)
		feldspar, quartz	Granitie (Gr) Gneiss (Gns)
		eye-shaped feldspar, mica	Augen (Au) Gneiss (Gns)

* Modified from Woodward, L.A., Laboratory Manual Physical Geology, 1988.

ATTACHMENT G



Compton, R.R., Manual of Field Geology, 1962.

ATTACHMENT H

COMMON ABBREVIATIONS		
Abundant - abnt	Diameter – dia	Laminated – lam
Amount – amt	Different – diff	Maximum – max
Approximate – approx	Disseminated – dissem	Pebble – pbl
Arenaceous – aren	Elevation – elev	Phenocryst – phen
Argillaceous – arg	Equivalent – equiv	Porphyritic – proph
Average – ave	foliated – fol	Probable – prob
Bedded – bdd	Formation frm	Quartz – qrz
Bedding – bdg	Fracture – frac	Regular – reg
Calcareous – calc	Fragmental – frag	Rocks – rx
Cemented – cmt	Granular – Gran	Rounded – rnd
Cobble – cbl	Gypsiferous – Gyp	saturated – sat
Contact – ctc	Horizontal – hriz	Secondary – sec
Cross-bedded - xbdd	Igneous – ign	Siliceous – sil
Cross-bedding – xbdg	Inclusion – incl	Structure – struc
Cross-laminated – xlam	Interbedded – intbdd	Unconformity – uncnf
Crystal – xl	Irregular – ireg	Variegated – vrgt
Crystalline – xln	Joint – jnt	Vein – vn
<u>Grain Size</u>	<u>Contacts</u>	<u>Sorting</u>
grain – gn	gradational – grad	poor – pr
fine – f	erosional – er	moderate – mod
very fine – vf	abrupt – ab	well – well
medium – med		
coarse – crs	<u>Fabric</u>	
large – lg	grain supported - gs	
very large – vlg	matrix supported – ms	
small – sm	imbricate - im	

Adapted from, Compton, R.R., Manual of Field Geology, 1962.

ATTACHMENT I

Naming of Unconsolidated Materials

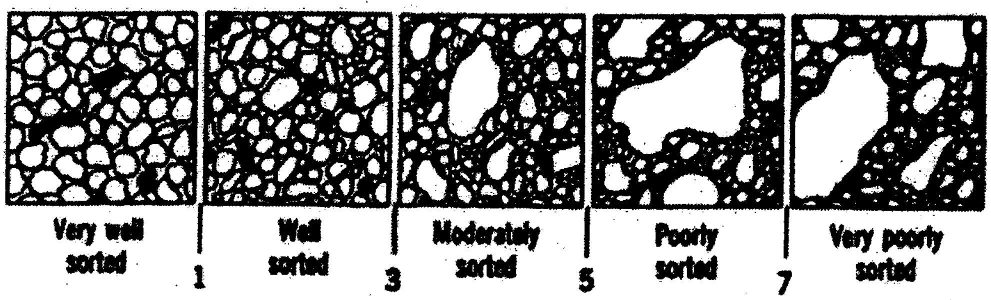
Main Particle	Gravel	Sand	silk	Clay
> 15 % gravel	Gravel	Gravelly Sand	Gravelly Silt	Gravelly Clay
> 15 % sand	Sandy Gravel	Sand	Sandy Silt	Sandy clay
> 15 % silt	Silty Gravel	Silty Sand	Silt	Silty Clay
> 15 % clay	Clayey Gravel	Clayey Sand	Clayey Silt	Clay
5-15 % gravel	Not Applicable	Sand with Gravel	Silt with Gravel	Clay with Gravel
5-15 % sand	Gravel with sand	Not applicable	Silt with Sand	Clay with sand
5-15 % silt	Gravel with silt	Sand with silt	Not applicable	Clay with silt
5-15 % clay	Gravel with clay	Sand with clay	Silt with clay	Not applicable
> 15% gravel plus 15% sand	Sandy Gravel	Gravelly Sand	Gravelly Sandy Silt	Gravelly Sandy Clay
> 15% gravel plus 15% silt	Silty Gravel	Gravelly Silty Sand	Gravelly Silt	Gravelly Silty Clay
> 15% gravel plus 15% clay	Clayey Gravel	Gravelly Clayey Sand	Gravelly Sandy Silt	Gravelly Clay
> 15% sand plus 15% silt	Silty Sand Gravel	Silty Sand	Sandy Silt	Sandy Silty Clay
> 15% sand plus 15% clay	Sandy Clayey Gravel	Clayey Sand	Sandy Clayey Silt	Sandy Clay
> 15% silt plus 15% clay	Silty Clayey Gravel	Silty Clayey Sand	Clayey Silt	Silty Clay

NOTE: Other combinations are possible when all particle sizes are present in greater than 15%. For example, a Silty Clayey Gravelly Sand. Other possible combinations exist such as a Gravelly Sand with silt.

Compton, R.R., Manual of Field Geology, 1962.

ATTACHMENT J

Sorting Chart



Compton, R.R., Manual of Field Geology, 1962.

ATTACHMENT K

Example of Unified Soil Classification System (USCS)

Unified Soil Classification System (USCS)

	MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS	> 300	> 11.8	-
COBBLES	75 - 300	2.9 - 11.8	-
GRAVEL: COARSE	75 - 19	2.9 - .75	-
FINE	19 - 4.8	.75 - .19	3/4" - No. 4
SAND: COARSE	4.8 - 2.0	.19 - .08	No. 4 - No. 10 
MEDIUM	2.0 - .43	.08 - .02	No. 10 - No. 40 
FINE	.43 - .08	.02 - .003	No. 40 - No. 200 
FINES: SILTS	< .08	< .003	< No. 200 
CLAYS	< .08	< .003	< No. 200

ATTACHMENT K

Example of Unified Soil Classification System (USCS)
(Continued)

CLAY

CLAY CONSISTENCY	THUMB PENETRATION	SPT, N BLOWS/ FT.	Undrained Shear Strength c (PSF)	Unconfined Compressive Strength q_u
			TORVANE	Pocket Penetrometer
VERY SOFT	Easily penetrated several inches by thumb. Exudes between thumb and finger's when squeezed in hand.	< 2	250	500
SOFT	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 - 4	250 - 500	500 - 1000
MEDIUM STIFF	Can be penetrated over 1/4 " by thumb with moderate effort. Molded by strong finger pressure.	4 - 8	500 - 1000	1000 - 2000
STIFF	Indented about 1/4" by thumb but penetrated only with great effort.	8 - 15	1000 - 2000	2000 - 4000
VERY STIFF	Readily indented by thumbnail.	15 - 30	2000 - 4000	4000 - 8000
HARD	Indented with difficulty by thumbnail.	> 30	> 4000	> 8000

SAND

SOILTYPE	SPT, N Blows/ft.	Relative Density,%	FIELD TEST
VERY LOOSE SAND	4	0 - 15	Easily penetrated with 1/2" reinforcing rod pushed by hand.
LOOSE SAND	4 - 10	15 - 35	Easily penetrated with 1/2" reinforcing rod pushed by hand.
MEDIUM DENSE SAND	10 - 30	35 - 65	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
DENSE SAND	30 - 50	65 - 85	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
VERY DENSE SAND	50	85 - 100	Penetrated only a few inches with 1/2" reinforcing rod driven with 5-lb hammer.

TSOP 4-1

FIELD LOGBOOK CONTENT AND CONTROL

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 4 - 1
Revision: 3
Date: October 14, 2004

SOP Title: FIELD LOGBOOK CONTENT AND CONTROL

QA Review: J Buford

Approved and Issued: J Litwin 11/1/04
Program Manager Signature/Date

Contract No.: RAC II Client: EPA Region II

Reason for Clarification: Make SOP EPA Region II - Specific

5.0 PROCEDURES
5.2 Operation

Other specific information that will be recorded in the project logbook includes:

- Schedule for the day
- Sample container and demonstrated analyte-free water shipment lot numbers (as received in the field)
- Equipment used (record ID number, where available)
- Equipment decontamination procedures
- Descriptions of any photographs taken and photolog entries as specified in the CDM Federal SOP No. 4-2
- Problems encountered
- Notes of conversations with project coordinators

For each sample collected and shipped the following information will be recorded (at a minimum) in the field logbook.

- Names of field personnel
- CDM assigned sample number/location (use at least two permanent landmarks for reference points)
- Date sampled
- Date shipped
- Sample location number
- Corresponding Contract Laboratory Program Routine Analytical Service sample number
- Media type
- Type of analysis to be performed
- Sample volume and containers
- Any unusual discoloration or evidence of contamination

- Field parameter measurements (such as turbidity, temperature, pH, conductivity, dissolved oxygen, and oxidation reduction potential (Eh) readings of aqueous media)
- Calculations
- Preservatives added to the sample;
- Courier airbill number and means of delivery to the laboratory
- General observations

5.3 Post-Operation, add (on page 4 of 4):

The field logbooks will be stored, following field activities, in the CDM RAC II document control system.

Field Logbook Content and Control

SOP 4-1
Revision: 6
Date: March 2007

Prepared: Del Baird

Technical Review: Laura Splichal

QA Review: Jo Nell Mullins

Approved: E-Signed by Michael C. Malloy
VERIFY authenticity with ApproveIt

Signature/Date

Issued: E-Signed by P. Michael Schwan
VERIFY authenticity with ApproveIt

Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to set CDM Federal (CDM) criteria for content entry and form of field logbooks. Field logbooks are an essential tool to document field activities for historical and legal purposes.

2.0 Background

2.1 Definitions

Biota - The flora and fauna of a region.

Magnetic Declination Corrections - Compass adjustments to correct for the angle between magnetic north and geographical meridians.

2.2 Discussion

Information recorded in field logbooks includes field team names; observations; data; calculations; date/time; weather; and description of the data collection activity, methods, instruments, and results. Additionally, the logbook may contain deviations from plans and descriptions of wastes, biota, geologic material, and site features including sketches, maps, or drawings as appropriate.

3.0 General Responsibilities

Field Team Leader (FTL) - The FTL is responsible for ensuring that the format and content of data entries are in accordance with this procedure.

Site Personnel - All CDM employees who make entries in field logbooks during onsite activities are required to read this procedure before engaging in this activity. The FTL will assign field logbooks to site personnel who will be responsible for their care and maintenance. Site personnel will return field logbooks to the records file at the end of the assignment.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities should be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment

- Site-specific plans
- Field logbook
- Indelible black or blue ink pen
- Ruler or similar scale

5.0 Procedures

5.1 Preparation

In addition to this SOP, site personnel responsible for maintaining logbooks must be familiar with all procedures applicable to the field activity being performed. These procedures should be consulted as necessary to obtain specific information about equipment and supplies, health and safety, sample collection, packaging, decontamination, and documentation. These procedures should be located at the field office or vehicle for easy reference.

Field logbooks shall be bound with lined, consecutively numbered pages. All pages must be numbered before initial use of the logbook. Before use in the field, each logbook will be marked with a specific document control number issued by the document control administrator, if required by the contract quality implementation plan (QIP). Not all contracts require document control numbers. The following information shall be recorded on the cover of the logbook:

- Field logbook document control number (if applicable).
- Activity (if the logbook is to be activity-specific), site name, and location.
- Name of CDM contact and phone number(s) (typically the project manager).
- Start date of entries.
- End date of entries.
- In specific cases, special logbooks may be required (e.g., waterproof paper for stormwater monitoring).

The first few (approximately five) pages of the logbook will be reserved for a table of contents (TOC). Mark the first page with the heading and enter the following:

Table of Contents

Date/Description	Pages
(Start Date)/Reserved for TOC	1-5

The remaining pages of the table of contents will be designated as such with "TOC" written on the top center of each page. The table of contents should be completed as activities are completed and before placing the logbook in the records file.

5.2 Operation

Requirements that must be followed when using a logbook:

- Record work, observations, quantities of materials, calculations, drawings, and related information directly in the logbook. If data collection forms are specified by an activity-specific plan, this information does not need to be duplicated in the logbook. However, any forms used to record site information must be referenced in the logbook.
- Do not start a new page until the previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Do not erase or blot out any entry at any time. Indicate any deletion by a single line through the material to be deleted. Initial and date each deletion. Take care to not obliterate what was written previously.
- Do not remove any pages from the book.

Specific requirements for field logbook entries include:

- Initial and date each page.
- Sign and date the final page of entries for each day.
- Initial and date all changes.
- Multiple authors must sign out the logbook by inserting the following:
  Above notes authored by:
  - (Sign name)
  - (Print name)
  - (Date)
- A new author must sign and print his/her name before additional entries are made.
- Draw a diagonal line through the remainder of the final page at the end of the day.
- Record the following information on a daily basis:
  - Date and time
  - Name of individual making entry
  - Names of field team and other persons onsite
  - Description of activity being conducted including station or location (i.e., well, boring, sampling location number) if appropriate
  - Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction, and speed) and other pertinent data
  - Level of personal protection used
  - Serial numbers of instruments
  - Equipment calibration information
  - Serial/tracking numbers on documentation (e.g., carrier air bills)

Entries into the field logbook shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In these cases, the logbook must reference the automatic data record or form.

At each station where a sample is collected or an observation or measurement made, a detailed description of the location of the station is required. Use a compass (include a reference to magnetic declination corrections), scale, or nearby survey markers, as appropriate. A sketch of station location may be warranted. All maps or sketches made in the logbook should have descriptions of the features shown and a direction indicator. It is preferred that maps and sketches be oriented so that north is toward the top of the page. Maps, sketches, figures, or data that will not fit on a logbook page should be referenced and attached to the logbook to prevent separation.

Other events and observations that should be recorded include:

- Changes in weather that impact field activities.
- Deviations from procedures outlined in any governing documents. Also record the reason for any noted deviation.
- Problems, downtime, or delays.
- Upgrade or downgrade of personal protection equipment.
- Visitors to the site.

5.3 Post-Operation

To guard against loss of data as a result of damage or disappearance of logbooks, completed pages shall be periodically photocopied (weekly, at a minimum) and forwarded to the field or project office. Other field records shall be photocopied and submitted regularly and as promptly as possible to the office. When possible, electronic media such as disks and tapes should be copied and forwarded to the project office.

At the conclusion of each activity or phase of site work, the individual responsible for the logbook will ensure that all entries have been appropriately signed and dated and that corrections were made properly (single lines drawn through incorrect information, then initialed and dated). The completed logbook shall be submitted to the records file.

6.0 Restrictions/Limitations

Field logbooks constitute the official record of onsite technical work, investigations, and data collection activities. Their use, control, and ownership are restricted to activities pertaining to specific field operations carried out by CDM personnel and their subcontractors. They are documents that may be used in court to indicate dates, personnel, procedures, and techniques employed during site activities. Entries made in these logbooks should be factual, clear, precise, and nonsubjective. Field logbooks, and entries within, are not to be used for personal use.

7.0 References

Sandia National Laboratories. 1991. *Procedure for Preparing Sampling and Analysis Plan, Site-Specific Sampling Plan, and Field Operating Procedures,* QA-02-03. Albuquerque Environmental Program, Department 3220, Albuquerque, New Mexico.

Sandia National Laboratories. 1992. *Field Operation Procedure for Field Logbook Content and Control.* Environmental Restoration Department, Division 7723, Albuquerque, New Mexico.

TSOP 4-2

PHOTOGRAPHIC DOCUMENTATION OF FIELD ACTIVITIES

Photographic Documentation of Field Activities

SOP 4-2
Revision: 7
Date: March 2007

Prepared: David O. Johnson

Technical Review: Sharon Budney

QA Review: Jo Nell Mullins

Approved: E-Signed by Michael C. Malloy VERIFY authenticity with ApproveIt

Signature/Date

Issued: E-Signed by P. Michael Schwan VERIFY authenticity with ApproveIt

Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to provide standard guidelines and methods for photographic documentation, which include still and digital photography and videotape or DVD recordings of field activities and site features (geologic formations, core sections, lithologic samples, water samples, general site layout, etc.). This document shall provide guidelines designed for use by a professional or amateur photographer. This SOP is intended for circumstances when formal photographic documentation is required. Based on project requirements, it may not be applicable for all photographic activities.

2.0 Background

2.1 Definitions

Photographer - A photographer is the camera operator (professional or amateur) of still photography, including digital photography, or videotape or digital versatile discs (DVD) recording whose primary function with regard to this SOP is to produce documentary or data-oriented visual media.

Identifier Component - Identifier components are visual components used within a photograph such as visual slates, reference markers, and pointers.

Standard Reference Marker - A standard reference marker is a reference marker that is used to indicate a feature size in the photograph and is a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled marker is not available or its use is not feasible, it can be a common object of known size placed within the visual field and used for scale.

Slates - Slates are blank white index cards or paper used to present information pertaining to the subject/procedure being photographed. Letters and numbers on the slate will be bold and written with black indelible marking pens.

Arrows and Pointers - Arrows and pointers are markers/pointers used to indicate and/or draw attention to a special feature within the photograph.

Contrasting Backgrounds - Contrasting backgrounds are backdrops used to lay soil samples, cores, or other objects on for clearer viewing and to delineate features.

Data Recording Camera Back - A data recording camera back is a camera attachment or built-in feature that will record, at the very least, frame numbers and dates directly on the film.

2.2 Associated Procedures

- CDM Federal SOP 4-1, *Field Logbook Content and Control*

2.3 Discussion

Photographs and videotape or DVD recordings made during field investigations are used as an aid in documenting and describing site features, sample collection activities, equipment used, and possible lithologic interpretation. This SOP is designed to illustrate the format and desired placement of identifier components, such as visual slates, standard reference markers, and pointers. These items shall become an integral part of the "visual media" that, for the purpose of this document, shall encompass still photographs, digital photographs, videotape recordings (or video footage), and recordings on DVDs. The use of a photographic logbook and standardized entry procedures are also outlined. These procedures and guidelines will minimize potential ambiguities that may arise when viewing the visual media and ensure the representative nature of the photographic documentation.

3.0 General Responsibilities

Field Team Leader - The field team leader (FTL) is responsible for ensuring that the format and content of photographic documentation are in accordance with this procedure. The FTL is responsible for directing the photographer to specific situations, site features, or operations that the photographer will be responsible for documenting.

Photographer - The photographer shall seek direction from the FTL and regularly discuss the visual documentation requirements and schedule. The photographer is responsible for maintaining a logbook per Sections 5.1, 5.2.4, and 5.3.1 of this SOP. Responsibilities will be defined in the project sampling plan.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

A general list of equipment that may be used:

- 35mm camera or disposable single use camera (35mm or panoramic use)
- Digital camera
- Extra batteries for 35mm camera
- Video camera and appropriate storage media (e.g., video tapes, DVDs)
- Logbook
- Indelible black or blue ink pen
- Standard reference markers
- Slates
- Arrows or pointers
- Contrasting backgrounds
- Medium speed, or multi purpose fine-grain, color, 35mm negative film or slide film (project dependent)
- Data recording camera back (if available)
- Storage medium for digital camera

5.0 Procedures

5.1 Documentation

A commercially available, bound logbook will be used to log and document photographic activities. Review CDM Federal SOP 4-1, *Field Logbook Content and Control* and prepare all supplies needed for logbook entries.

Note: A separate photographic logbook is not required. A portion of the field logbook may be designated as the photographic log and documentation section.

Field Health and Safety Considerations

There are no hazards that an individual will be exposed to specific to photographic documentation. However, site-specific hazards may arise depending on location or operation. Personal protective equipment used in this operation will be site-specific and dictated through requirements set by the site safety officer, site health and safety plan, and/or prescribed by the CDM Federal Corporate Health and Safety Program. The photographer should contact the site safety officer for health and safety orientation before commencing field activities. The site health and safety plan must be read before entry to the site, and all individuals must sign the appropriate acknowledgement that this has been done.

The photographer should be aware of any potential physical hazards while photographing the subject (e.g., traffic, low overhead hazard, edge of excavation).

5.2 Operation

5.2.1 General Photographic Activities in the Field

The following sections provide general guidelines that should be followed to visually document field activities and site features using still/digital cameras and video equipment. Listed below are general suggestions that the photographer should consider when performing activities under this SOP:

- The photographer should be prepared to make a variety of shots, from close-up to wide-angle. Many shots will be repetitive in nature or format, especially close-up site feature photographs. Consideration should therefore be given to designing a system or technique that will provide a reliable repetition of performance.
- All still film photographs should be made using a medium speed, or multi purpose fine-grain, color negative film in the 35mm format unless otherwise directed by the FTL.
- It is suggested that Kodak brand "Ektapress Gold Deluxe" film or equivalent be used as the standard film for the still photography requirements of the field activities. This film is stable at room temperature after exposure and will better survive the time lag between exposure and processing. It is suggested that film speed ASA 100 should be used for outdoor photographs in bright sunlight, ASA 200 film should be used in cloudy conditions, and ASA 400 film should be used indoors or for very low-light outdoor photographs.
- No preference of videotape or DVD brand along with digital storage medium is specified and is left to the discretion of the photographer.
- The lighting for sample and feature photography should be oriented toward a flat condition with little or no shadow. If the ambient lighting conditions are inadequate, the photographer should be prepared to augment the light (perhaps with reflectors or electronic flash) to maintain the desired visual effect.
- Digital cameras have multiple photographic quality settings. A camera that obtains a higher resolution (quality) has a higher number of pixels and will store a fewer number of photographs per digital storage medium.

5.2.2 General Guidelines for Still Photography

Slate Information

It is recommended that each new roll of film or digital storage medium shall contain on the first usable frame (for film) a slate with consecutively assigned control numbers (a consecutive, unique number that is assigned by the photographer as in sample numbers).

Caption Information

All still photographs will have a full caption permanently attached to the back or permanently attached to a photo log sheet. The caption should contain the following information (digital photographs should have a caption added after the photographs are downloaded):

- Film roll control number (if required) and photograph sequence number
- Date and time
- Photographer
- Description of activity/item shown (e.g., name of facility/site, specific project name, project number)
- Direction (if applicable)

When directed by the sampling plan, a standard reference marker should be used in all documentary visual media. While the standard reference marker will be predominantly used in close-up feature documentation, inclusion in all scenes should be considered.

Digital media should be downloaded at least once each day to a personal computer; the files should be in either "JPEG" or "TIFF" format. Files should be renamed at the time of download to correspond to the logbook. It is recommended the electronic files be copied to a compact disc for backup.

Close-Up and Feature Photography

When directed by the sampling plan, close-up photographs should include a standard reference marker of appropriate size as an indication of the feature size and contain a slate marked with the site name and any identifying label, such as a well number or core depth, that clearly communicates to the viewer the specific feature being photographed.

Feature samples, core pieces, and other lithologic media should be photographed as soon as possible after they have been removed from their in situ locations. This enables a more accurate record of their initial condition and color. When directed by the sampling plan, include a standard reference color strip (color chart such as Munsell Soil Color Chart or that available from Eastman Kodak Co.) within the scene. This is to be included for the benefit of the viewer of the photographic document and serves as a reference aid to the viewer for formal lithologic observations and interpretations.

Site Photography
Site photography, in general, will consist predominantly of medium- and wide-angle shots. A standard reference marker should be placed adjacent to the feature or, when this is not possible, within the same focal plane.

While it is encouraged that a standard reference marker and caption/slate be included in the scene, it is understood that situations will arise that preclude their inclusion within the scene. This will be especially true of wide-angle shots. In such a case, the film/tape control number shall be entered in the photographic logbook along with the frame number and all other information pertinent to the scene.

Panoramic
In situations where a wide-angle lens does not provide sufficient subject detail, a single-use disposable panoramic camera is recommended. If this type of camera is not available, a panoramic series of two or three photos would be appropriate. Panoramas can provide greater detail while covering a wide subject, such as an overall shot of a site.

To shoot a panoramic series using a standard 35mm or digital camera, the following procedures are recommended:

- Use a stable surface or tripod to support the camera
- Allow a 20- to 30-percent overlap while maintaining a uniform horizon
- Complete two to three photos per series

5.2.3 General Photographic Documentation Using Video Cameras
As a reminder, it is not within the scope of this document to set appropriate guidelines for presentation or "show" videotape or DVD recording. The following guidelines are set for documentary videotape or DVD recordings only and should be implemented at the discretion of the site personnel.

Documentary videotape or DVD recordings of field activities may include an audio slate for all scenes. At the beginning of each video session, an announcer will recite the following information: date, time (in military units), photographer, site ID number, and site location. This oral account may include any additional information clarifying the subject matter being recorded.

A standard reference marker may be used when taking close-up shots of site features with a video camera. The scene may also include a caption/slate. It should be placed adjacent and parallel to the feature being photographed.

It is recommended that a standard reference marker and caption/slate be included in all scenes. The caption information is vital to the value of the documentary visual media and should be included. If it is not included within the scene, it should be placed before the scene.

Original video recordings will not be edited. This will maintain the integrity of the information contained on the videotape or DVD. If editing is desired, a working copy of the original video recording can be made.

A label should be placed on the videotape or DVD with the appropriate identifying information (project name, project number, date, location, etc.).

5.2.4 Photographic Documentation
Photographic activities must be documented in a photographic logbook or in a section of the field logbook. The photographer will be responsible for making proper entries.

In addition to following the technical standards for logbook entry as referenced in CDM Federal SOP 4-1, the following information should be maintained in the appropriate logbook:

- Photographer name.
- If required, an entry shall be made for each new roll/tape/DVD control number assigned.
- Sequential tracking number for each photograph taken (for digital cameras, the camera-generated number may be used).
- Date and time (military time).
- Location.
- A description of the activity/item photographed.
- If needed, a description of the general setup, including approximate distance between the camera and the subject, may be recorded in the logbook.
- Record as much other information as possible to assist in the identification of the photographic document.

5.3 Post Operation

All film will be sent for development and printing to a photographic laboratory (to be determined by the photographer). The photographer will be responsible for arranging transport of the film from the field to the photographic laboratory. The photographer shall also be responsible for arranging delivery of the negatives and photographs, digital storage medium, or videotape or DVD to the project management representative to be placed in the project files.

5.3.1 Documentation

At the end of each day's photographic session, the photographer(s) will ensure that the appropriate logbook has been completely filled out and maintained as outlined in CDM Federal SOP 4-1.

5.3.2 Archive Procedures

- Photographs and the associated set of uncut negatives, digital media, and original unedited documentary video recordings will be submitted to the project files and handled according to contract records requirements. The project manager will ensure their proper distribution.
- Completed pages of the appropriate logbook will be copied weekly and submitted to the project files.

6.0 Restrictions/Limitations

This document is designed to provide a set of guidelines for the field amateur or professional photographer to ensure that an effective and standardized program of visual documentation is maintained.

It is not within the scope of this document to provide instruction in photographic procedures, nor is it within the scope of this document to set guidelines for presentation or "show" photography.

The procedures outlined herein are general by nature. The photographer is responsible for specific operational activity or procedure. Questions concerning specific procedures or requirements should be directed to the project manager or FTL.

Note: Some sites do not permit photographic documentation. Check with the site contact for any restrictions.

7.0 References

U. S. Army Corps of Engineers. 2001. *Requirements for the Preparation of Sampling and Analysis Plans*, EM 200-1-3. Appendix F. February.

U. S. Environmental Protection Agency. 1992. National Enforcement Investigations Center. *Multi-Media Investigation Manual*, EPA-330/9-89-003-R. p. 85. Revised March.

__________. Region IV. 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. Athens, Georgia. November.

TSOP 4-3

WELL DEVELOPMENT AND PURGING

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: WELL DEVELOPMENT AND PURGING

SOP No.: 4-3
Revision: 3
Date: October 14, 2004

QA Review: J Orford

Approved and Issued: J Leturn 11/1/04
Program Manager Signature/Date

Contract No.: RAC II Client: EPA Region II

Reason for Clarification: Make SOP EPA Region II - Specific

4.0 REQUIRED EQUIPMENT

- Dissolved oxygen (D.O.) meter

5.0 PROCEDURES

5.1 Well Development

Under Step 7, (page 2 of 4), add;
Development will be considered complete when a visually sediment-free discharge is achieved and the pH, temperature, specific conductivity, and dissolved oxygen remain consistent within a +/- ten percent range. In addition, during development monitor and record the water level in the well, the pumping flow rate, and the total volume of water purged from the well.

5.2 Volumetric Method of Well Purging

Under Step 6, (page 3 of 4), add:
During well purging monitor the dissolved oxygen concentration, the water level in the well, the flow rate, and the total volume of water purged from the well.

Under Step 7, (page 3 of 4), add:
Any water removed during evacuation should not be reintroduced into the well as it can no longer be considered a representative portion of the aquifer.

5.3 Indicator Parameter Method of Well Purging

Under step 8, (page 4 of 4), add:
Any water removed during evacuation should not be reintroduced into the well as it can no longer be considered a representative portion of the aquifer.

7.0 REFERENCES, add (on page 4 of 4)

U.S. Environmental Protection Agency, Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual*, Final Copy, Revision 1, October 1989.

Well Development and Purging

SOP 4-3
Revision: 5
Date: March 2007

Prepared:	Del R. Baird	**Technical Review:**	John Hofer
QA Review:	Jo Nell Mullins	**Approved:**	E-Signed by Michael C. Malloy VERIFY authenticity with ApproveIt
Issued:	E-Signed by P. Michael Schwan VERIFY authenticity with ApproveIt		Signature/Date
	Signature/Date		

1.0 Objective

The purpose of this standard operating procedure (SOP) is to define the procedural requirements for well development and purging.

2.0 Background

Monitoring wells are developed to repair damage to the formation caused by drilling activities and to settle and remove fines from the filter pack. Wells shall not be developed for at least 24 to 48 hours after completion when a cement bentonite grout is used to seal the annular space; however, wells may be developed before grouting if conditions warrant. Wells are purged immediately before groundwater sampling to remove stagnant water and to sample representative groundwater conditions. Wells shall be sampled within 3 hours of purging (optimum) to 24 hours after purging (maximum for low recharge conditions).

2.1 Associated Procedures

- CDM Federal SOP 1-6, *Water Level Measurement*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and for verifying that development and purging are carried out in accordance with this procedure.

Field Team Leader - The field team leader is responsible for complying with this procedure.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment

- Pump, pump tubing, or bailer and rope or wire line
- Power source (e.g., generator), if required
- Electronic water-level meter
- Temperature, conductivity, pH, and turbidity meters
- Personal protective equipment as specified in the site-specific health and safety plan
- Decontamination supplies, as required, according to CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*
- Disposal drums, if required
- Photoionization detector (PID) or equivalent as specified in site-specific health and safety plan

5.0 Procedures

5.1 Well Development

The following steps must be followed when developing wells:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.

2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.

3. Open the well cover and check condition of the wellhead, including the condition of the surveyed reference mark, if any.

4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.

5. Determine the depth to static water level and depth to bottom of the well.

6. Prepare the necessary equipment for developing the well. There are a number of techniques that can be used to develop a well. Some of the more common methods are bailing, overpumping, backwashing, mechanical surging, surge and pump, wire brush, swabbing, and high-velocity jetting. All of these procedures are acceptable; however, final approval of the development method rests with the appropriateness of a specific method to the site and the client.

7. For screened intervals longer than 10 feet (3 meters [m]), develop the well in 2- or 3-foot (0.75- or 1-m) intervals from bottom to top. This will ensure proper packing of the filter pack.

8. Continue well development until produced water is clear and free of suspended solids, as determined by a turbidity meter or when pH, conductivity, and temperature have stabilized. Record pertinent data in the field logbook and on appropriate well development forms. Remove the pump assembly or bailers from the well, decontaminate (if required), and clean up the area. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plans.

5.2 Volumetric Method of Well Purging

The following steps shall be followed when purging a well by the volumetric method:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.

2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.

3. Open the well cover and check condition of the wellhead, including the condition of the surveyed reference mark, if any.

4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.

5. Determine the depth to static water level and depth to bottom of well casing according to CDM Federal SOP 1-6, *Water Level Measurement*. Calculate the volume of water within the well bore using the following formula (or equivalent):

$$7.4805 \left[\frac{D^2\pi}{(4)} \right] dH = \text{volume (in gallons)}$$

where
D = casing diameter in feet. (***Note***: This equation is used for grouted wells with short screens. For wells with long screens and/or ungrouted wells, the D = borehole diameter in feet).
dH = the distance from well bottom to static water level in feet.
π = 3.1416.

Note: Record all data and calculations in the field logbook.

6. Prepare the pump and tubing, or bailer, and lower it into the casing.

7. Remove the number of well volumes specified in the site-specific plans. Generally, three to five well volumes will be required. Conductivity, pH, temperature, and turbidity shall be measured and recorded. Purging shall continue until the field parameters have stabilized. Groundwater quality parameters are considered stable when three consecutive readings are within ± 0.1 for pH, ±3 percent for conductivity, ±10 mv for redox potential (ORP), and ±10 percent for turbidity if greater than 10 NTU, in accordance with site-specific plans. Efforts shall be made to get turbidity below 10 NTU, especially if groundwater samples are to be collected for metals or PCB analyses.

8. In low recharge aquifers, the following steps shall be followed: (1) If the initial water level is less then 10 feet above the top of the screen, then purge to dryness and allow sufficient recharge to collect samples. (2) If initial water level in the well is more than 10 feet above the top of the screen, then care shall be taken to prevent the dewatering of the screened interval. (3) Continue purging until the water level is between 1 and 5 feet above the top of the screen. (4) Allow well to recharge then continue purging until at least 1 full initial well volume has been purged. (5) Record pertinent data in the field logbook.

9. Groundwater sampling shall be performed immediately upon completion of purging (unless time for recharge is required for low-recharge wells) using the same equipment that was used for purging. Unfiltered samples shall be collected first, beginning with volatiles organic compounds (VOCs). After all unfiltered samples have been collected, a 0.45 micron in-line filter shall be installed in the discharge line for collection of filtered samples, if required.

10. After sampling activities have been completed, remove the pump assembly or bailer from the well, decontaminate it (if required), and clean up the site. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plan.

5.3 Indicator Parameter Method of Well Purging

1. Review site-specific health and safety plan and project plans before initiating sampling activity.

2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.

3. Open the well cover and check the condition of the wellhead, including the condition of the surveyed reference mark, if any.

4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.

5. Determine the depth to static water level and depth to bottom. Set up surface probe(s), (e.g., pH, conductivity) at the discharge orifice or dedicated probe port of the pump assembly or within the flow-through chamber. Allow probe(s) to equilibrate according to manufacturer's specifications. Record the equilibrated readings in the field logbook.

6. Assemble the pump and tubing, or bailer, and lower into the casing.

7. Begin pumping or bailing the well. Record indicator parameter readings for every 5 minutes or purge volume, whichever is quicker. Maintain a record of the approximate volumes of water produced. Care shall be taken to minimize drawdown (0 to 0.2 feet).

8. Continue pumping or bailing until indicator parameter readings remain stable within ± 0.1 for pH, ±3 percent for conductivity, ±10 mv for redox potential (ORP), and ±10 percent for turbidity if greater than 10 NTU for three consecutive recording intervals and a minimum of 1 well volume is removed, or in accordance with site-specific plans. Purging shall continue until the discharge stream is clear or turbidity becomes asymptotic-low or meets proje[illegible] requirements.

9. For a low recharge aquifer, follow the guidelines of Section 5.2, Paragraph 7.

10. Groundwater sampling shall be performed immediately upon completion of purging (unless time for recharge is required for low-recharge wells) using the same equipment that was used for purging. Unfiltered samples shall be collected first, beginning with VOCs. After all unfiltered samples have been collected, a 0.45 micron in-line filter shall be installed in the discharge line for collection of filtered samples, if required.

11. Remove the pump assembly or bailer from the well, decontaminate (if required), and clean up the site. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plans.

6.0 Restrictions/Limitations

Where flammable, free, or emulsified product is expected, or known to exist on or in groundwater, use intrinsically safe electrical devices only and place portable power sources (e.g., generators) 50 feet (15 m) or further from the wellhead and disposal drums.

7.0 References

American Society for Testing and Materials. 2005. Designation: D 5521, *Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers*, Rev. 5, November.

U. S. Army Corps of Engineers. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites, EM 1110-1-4000*, Chapter 6. November 1.

U. S. Department of Energy, Environmental Restoration Project. 2001. *Standard Operating Procedure for Well Development*, ER-2001-0379, Rev. 2, Los Alamos, New Mexico. April 27.

U. S. Environmental Protection Agency, Region III, 1997. *Low-Flow Purging and Sampling of Groundwater Monitoring Wells*, Bulletin No. QAD023, Philadelphia, Pennsylvania. October.

U. S. Environmental Protection Agency. 2002. *Groundwater Sampling Guidelines for Superfund and RCRA Project Managers.* Ground Water Forum Issue Paper, EPA 542-S-02-001, OSWER, Technology Innovative Office, Washington, D.C. May.

TSOP 4-4

DESIGN AND INSTALLATION OF MONITORING WELLS IN AQUIFERS

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: DESIGN & INSTALLATION OF MONITORING WELLS IN AQUIFERS

SOP No.: 4-4
Revision: 3
Date: October 14, 2004

QA Review: J Buford

Approved and Issued: J Lituri 11/1/04
Program Manager Signature/Date

Contract No.: RAC II Client: EPA Region II

Reason for Clarification: Make SOP EPA Region II - Specific

2.2 Discussion

When constructing wells in New Jersey follow the New Jersey Department of Environmental Protection (NJDEP) guide lines for monitoring well construction.

When designing a monitoring well and planning the drilling program, take into account that cement grout will generate heat while it is setting. Make sure that the casing material used in well construction can withstand the heat and that, if necessary, the grout is installed in lifts to avoid overheating the casing which may cause it to fail.

5.2.5 Installation of the Bentonite Seal

Under this item on page 8 of 10, add:

No. 00 sand (or equivalent) may be used in place of bentonite pellets as an annular seal above the filter pack. Calculate the volume of bentonite or #00 sand required to fill the annular space before beginning installation. This will help you determine if sufficient material has been emplaced. If the amount used is significantly less or more than the amount calculated than consult with the driller to determine the cause of the discrepancy and the best way to address the issue.

4.0 REQUIRED EQUIPMENT AND MATERIALS

4.1 Equipment

- Mud balance (for checking density of grout)

4.2 Required Construction Materials

Under Slot Size (page 3 of 10), add:

If necessary to select a slot size compatible with the formation and sand pack, follow the procedures for screen slot size selection discussed in *Groundwater and Wells* (Driscoll 1986).

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 4-4
Revision: 3
Date: October 14, 2004

SOP Title: **DESIGN & INSTALLATION OF MONITORING WELLS IN AQUIFERS**

Under Grout (page of 3 of 10), add:
When constructing wells in New Jersey follow the NJDEP guide lines for monitoring well construction regarding preparation of grout (NJDEP 2004). If a bentonite slurry is used to grout the annular space, use a product designed to produce a pumpable mixture with the required percent solids.

Under Well Screen (page 2 of 10), add:
Monitoring well screens should be 5 to 10 feet in length to avoid dilution of the contaminated groundwater with water from less contaminated zones in this aquifer. In New Jersey, consult current NJDEP requirements for well construction regarding the maximum screen length allowed.

Under Transition Sand (page 4 of 10) add:
Number 00 sand (or equivalent) may be used in place of a bentonite annular seal above the filter pack.

5.2.4 Installation of the Primary Filter Pack
Under this item on page 8 of 10, add:
Calculate the volume of sand required to fill the annular space before beginning installation. This will help you determine if sufficient sand has been emplaced. If the amount used is significantly less or more than the amount calculated than consult with the driller to determine the cause of the discrepancy and the best way to address the issue.

5.2.5 Installation of the Bentonite Seal
Under this item on page 8 of 10, add:
No. 00 sand (or equivalent) may be used in place of bentonite pellets as an annular seal above the filter pack. Calculate the volume of bentonite of #00 sand required to fill the annular space before beginning installation. This will help you determine if sufficient material has been emplaced. If the amount used is significantly less or more than the amount calculated than consult with the driller to determine the cause of the discrepancy and the best way to address the issue.

5.3 Well Protection
Under this item on page 9 of 10, add:
Whenever possible do not install a flush mounted monitoring well in a parking lot or road. In this situation, the protective casing is very vulnerable to damage and failure thereby creating a potential pathway for surface water runoff to enter the well. Instead, locate the well in a traffic island or off the edge of a parking area.

When installing a stickup protective casing, install filter pack inside the protective casing to within about 6 inches of the top of the well casing to prevent insects from nesting inside the well.

7.0 REFERENCES, add (on page 10 of 10)
NJDEP Monitoring Well Construction Requirements. http://www.state.nj.us/dep/watersupply/well.htm
U.S. Environmental Protection Agency, Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual*, Final Copy, Revision 1, October 1989.

Design and Installation of Monitoring Wells in Aquifers

SOP 4-4
Revision: 6
Date: March 2007

Prepared: Del Baird

Technical Review: John Hofer

QA Review: Jo Nell Mullins

Approved: E-Signed by Michael C. Malloy VERIFY authenticity with ApproveIt

Signature/Date

Issued: E-Signed by P. Michael Schwan VERIFY authenticity with ApproveIt

Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to provide guidelines for the installation of groundwater monitoring wells. These guidelines will help to produce consistency of approach in the design and installation of monitoring wells. Individual installations will probably vary in some respects since they may encounter differing hydrogeologic conditions.

2.0 Background

2.1 Definitions

Monitoring Well Installation - The act of installing well casing, screen, filter pack, bentonite seal, grout, and other specified materials in a borehole to construct a complete monitoring well.

2.2 Associated Procedures

- CDM Federal SOP 3-5, *Lithologic Logging*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-2, *Photographic Documentation of Field Activities*
- CDM Federal SOP 4-3, *Well Development and Purging*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

This SOP is intended to cover the installation of monitoring wells for use in conducting a variety of environmental investigations. It is intended to be a general guideline listing the types of materials and methods to be considered when a well is installed. Materials are not specified in detail since it is likely there will be wide variability required to meet the needs of individual site conditions or specific clients. Ideally, the well shall not alter the medium that is being sampled.

3.0 General Responsibilities

Site Manager - Translates client's requirements into technical direction of project. Sets technical criteria, reviews and approves technical progress, and ensures that all participating personnel have proper training. ***Note***: Other titles such as project manager may be used.

Field Team Leader (FTL) - Supervises field operations. Ensures that all necessary equipment including safety equipment is available and functioning properly before project operations begin. Ensures that all necessary personnel are mobilized on time. Maintains daily log of activities each work day.

Field Geologist - Collects and maintains data and completes Monitoring Well Construction Forms. Coordinates and consults with site manager on decisions relative to unexpected encounters during well installation and deviation from this SOP. Directs overall activities of drill and support subcontractors.

Drilling Subcontractor - Provides necessary personnel, equipment, and services to meet terms of the contract.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment and Materials

4.1 Required Equipment

- Field logbook
- Monitoring Well Construction Forms
- Measuring tape

4.2 Required Construction Materials

General - The materials that are used in the construction of a monitoring well and that come in contact with the groundwater shall not measurably alter the chemical quality of a groundwater sample. The well casing and well screen shall be steam cleaned (if appropriate for the selected material) before well installation or certified clean from the manufacturer and delivered to the site in protective wrapping. Samples of the cleaning water, drilling fluids, filter pack, annular seal, and mixed grout shall be retained to be analyzed if groundwater contamination as the result of well installation is suspected. These samples will serve as quality control checks until the completion of at least one round of groundwater quality sampling and analysis.

Water - Water, which may be used in the well completion process, shall be obtained from a source that does not contain constituents that could compromise the integrity of the well installation. A certificate of analysis shall be provided with the water, or a sample of the water shall be analyzed and documented as contaminant-free.

Surface (Isolation) Casing - Surface, or isolation, casing may be required to isolate an upper aquifer while drilling and installing deep wells. The isolation casing usually consists of black steel or polyvinyl chloride (PVC). Surface casings shall be large enough to allow a minimum annular space of 2 inches between it and the well casing. Segments of black steel casings are typically welded together as the casing is lowered down the borehole. PVC isolation casings are either flush-threaded or have a bell shape at one end so that sections slip together and are held with small stainless steel screws. Casings shall be grouted in place and allowed to set for 12 to 24 hours before advancing the borehole below the casing.

Well Screen - The well screen shall be new and composed of materials most suited for the environment being monitored. The screened interval shall be plugged at the bottom. The plug shall be of the same material as the bottom section of screen and shall be securely attached, making a positive seal. This assembly must have the capability to withstand well installation and development stresses without becoming dislodged or damaged. The length of the well screen slotted area shall be appropriate for the interval to be monitored including some allowance for changes in elevation of the water table. Before installation, the casing string and associated equipment shall be cleaned with steam or high-pressure water, if not certified cleaned. Well screens shall be stainless steel or PVC, as appropriate. Fluoropolymer materials may be substituted if necessary because of the potential for incompatible chemical reactions between contaminants and the stainless steel screen, or if stainless steel constituents are possible site contaminants. The minimum inside diameter of the well screen shall be chosen based on the particular application. Well screens shall be flush threaded per American Society for Testing and Materials (ASTM) standards. Glued or solvent-welded joints may not be used since glues and solvents may alter the chemistry of the water samples.

The slot size of the well screen shall be determined relative to the grain-size analysis of the stratum to be monitored and the gradation of the filter pack material. In granular, noncohesive, strata that falls in easily around the screen, filter packs may not be necessary. In these cases of natural development, the slot size of the well screen is to be determined using the grain size of the surrounding strata. The slot size and arrangement shall retain at least 90 percent of the filter pack.

Casing - The well casing will be PVC, stainless steel, or some other appropriate material and will extend from the screen to the surface. The type of casing and wall thickness shall be adequate to withstand the forces of installation. Several different casing sizes may be required depending on the subsurface geologic conditions. The diameter of the casing for filter packed wells shall be selected so that a minimum annular space of 2 inches is maintained between the casing and the borehole wall. The diameter of the casings in multi-cased wells shall be selected so that a minimum annular space of 2 inches is maintained between casing strings and between the outer casing and the borehole (e.g., a 2-inch-diameter well screen will require first setting a 6-inch-diameter casing in a 10-inch-diameter boring). Under difficult drilling conditions (collapsing soils, rock, or cobbles), it may be necessary to advance temporary casing. Under these conditions, a smaller space may be maintained. The ends of each casing section shall be flush-threaded.

Primary Filter Pack - The primary filter pack (sand or gravel pack) consists of a clean, well-sorted, rounded granular material of selected grain size and gradation that is installed in the annulus between the screened interval and the borehole wall. The filter pack may be installed along the screened interval using a tremie pipe from the total depth of the well to the designated distance above the top of the screened interval. A filter pack material mostly consisting of siliceous, rather than calcareous, particles is preferred. Select the grading of the filter pack on the basis of the layer of finest material to be screened. A minimum filter pack thickness shall be between 2 to 3 inches and generally shall never be greater than 8 inches. The filter pack shall extend at least 2 to 3 feet above the screened interval or more depending on the screen length to provide for filter pack settlement.

Transition Sand - A layer of fine to very fine sand may be placed on top of the primary filter pack before emplacement of the bentonite seal. The sand shall be of sufficient thickness to prevent bentonite from penetrating to the vicinity of the well screen during placement of the bentonite seal.

Annular Sealants - The materials used to seal the annulus may be prepared as a slurry or used unmixed in a dry pellet form. Sealants shall be selected for compatibility with local geologic, hydrogeologic, climatic, and human-induced conditions anticipated to occur during the life of the well.

Grout - The grout backfill that is placed above the bentonite annular seal shall be a liquid slurry consisting of water, bentonite grout of Volclay or equivalent quality, and portland cement. Bentonite-based grouts are typically used when a more flexible grout is desired (i.e., freeze-thaw). Cement-based grout provides a more rigid installation. A typical bentonite grout mixture is 1 to 1.25 pounds bentonite to 2 pounds of Type I portland cement per gallon of water. Cement-based grout is typically 6 to 7 gallons of water per 94 pound bag of Type I portland cement and 2.7 percent bentonite powder.

Bentonite - Bentonite shall be powdered or pelletized sodium montmorillonite furnished in sacks or buckets from a commercial source and free of impurities that adversely impact water quality in the well. The diameter of pellets selected for monitoring well construction shall be less than one-fifth the width of the annular space into which they are placed to reduce the potential for bridging. Pellets are typically used for placing annular seals, and powdered bentonite is used for mixing in grout slurry.

Cement - Each type of cement has slightly different characteristics that may be appropriate under various physical and chemical conditions. Cement shall generally be portland Type I, Type II, or Type I/II as specified in ASTM C 150. Quick-setting cements containing additives are not allowable for use in monitoring well installation. Additives may leach from the cement and influence the chemistry of the groundwater.

Annular Seal Equipment (Tremie Pipe) - A tremie pipe is used to inject the annular seals and filter pack. Tremie pipes are typically constructed of PVC or galvanized steel. Associated equipment may include a trough or mixing box and "mud pump" to place the material.

Protective Casing - Protective casings are installed on wells placed in overgrown or nontraffic areas. The casings may be made of galvanized steel (or rarely stainless steel and shall have a lid capable of being secured by a locking device. The inside dimensions of the protective casing shall be at a minimum 4 inches larger than the diameter of the casing to facilitate the installation and operation of sampling equipment. Protective casing shall extend approximately 2 to 3 feet into the ground to anchor it securely. Protective casings are typically set in concrete pads measuring 2 feet x 2 feet to 4 feet x 4 feet and 4 to 6 inches thick depending on client requirements.

Flush-Mount Protective Covers - Flush-mount covers (Christy boxes) are installed over wells place in paved or manicured areas. The covers are typically 8 inches in diameter with a 1-foot galvanized steel skirt and cast iron bolt-down ring and lid. The covers are installed in concrete pads measuring 2 to 3 feet square that are constructed so as to not impede vehicle traffic and sloped from the center toward the edges to prevent infiltration of run-off water.

5.0 Procedures

5.1 Drilling Methods

The actual methods of drilling at a site will vary depending on site conditions. The method to be used at a site shall be stated in the site-specific plans. Deviations from the methods prescribed in these plans shall be approved by the FTL or designee. Typical drilling methods include air rotary or hammer, mud/fluid rotary, rotosonic, and hollow-stem auger. Drilling with mud or water is least desirable, but the driller shall have the capability to use this method if borehole conditions warrant it. Installation of isolation casing, if required, shall be done by either penetrating the outer casing into the ground by hammer blows or by drilling a borehole. The outer casing shall be set and secured by grouting or other means specified in the site-specific plans. The inner well borehole can then be drilled through the center of the outside casing. The monitoring wells shall be drilled vertical or at an angle if specified in the site-specific plans. The wells shall be drilled to a depth specified in the site-specific plans and may vary based on actual lithologic conditions. The depth to completion shall be approved by the FTL or designee before monitoring well construction. Drillers must prevent grease, oil, and other fluids from the drill rig from coming in contact with the ground around the area of well installation.

Collection of continuous core may be required during borehole drilling. Samples may be collected by several methods depending on project needs and the material being sampled including split-spoon sampler, direct-push, or sonic coring (unconsolidated material), or wire-line coring (bedrock). A description of soil/lithologic materials and drilling observations needs to be recorded on a boring log or in a logbook (CDM Federal SOP 3-5).

5.2 Monitoring Well Installation

5.2.1 Stable Borehole

A stable borehole must be constructed before attempting to install the monitoring well. Steps must be taken to stabilize the borehole before attempting installation if the borehole tends to cave or blow-in, or both. Boreholes that are not straight or are partially obstructed shall be corrected before attempting the installations described herein.

Although all monitoring wells will not be completed exactly alike, there are common elements among them. The Monitoring Well Construction Form(s) (Figures 1, 2, 3, and 4 or equivalent) must be completed by the end of the activity with data obtained through the installation process. Modification of the construction and dimensions on this diagram may be needed depending on site-specific conditions. The well construction field form shall be reviewed before initiation of drilling activities to ensure that the required data are collected at appropriate times during drilling and installation.

5.2.2 Well Casing Assembly

The well screen, casing, and bottom plug shall be either certified clean from the manufacturer or decontaminated according to CDM Federal SOP 4-5.

The casing shall be flush-threaded, using Schedule 40 PVC or other suitable monitoring well casing. No adhesives, cements, or lubricants shall be used during casing make-up or during other drilling and well completion operations. Personnel shall take precautions to ensure that grease, oil, or other contaminants that may alter water samples do not contact any portion of the well casing assembly. As a precaution, personnel shall wear a pair of clean gloves while handling the assembly.

Normally, couplings are tightened by hand; however, steam- or high-pressure-cleaned strap wrenches may also be used. Use pipe wrenches with care as they may scar and weaken the pipe. Precautions shall be taken to prevent damage to the threaded joints during installation.

5.2.3 Setting the Well Screen and Casing Assembly in Fluid Filled Holes

When the well screen and casing assembly is lowered to the predetermined level and held in position, the assembly may require a ballast to counteract the tendency to float in the borehole. Ballasting may be accomplished by continuously filling the casing assembly with contaminant-free water. If fluid ballasts are used, the quantity introduced must be recorded in the field logbook. Alternatively, the casing assembly may be slowly pushed into the fluid in the borehole with the aid of hydraulic rams on the drill rig and held in place as additional sections of casing are added to the column. Care must be taken to secure the casing assembly so that personnel safety is ensured during the installation. For wells greater than 100 feet, the assembly shall be installed straight using centralizers at selected intervals.

The casing shall extend to grade or approximately 2 feet above grade, depending on the intended surface completion, and be capped or covered temporarily to deter entrance of foreign materials during completion operations.

5.2.4 Installation of the Primary Filter Pack

Placement of the casing assembly is followed by placing the primary filter pack (consisting of silica sand sized according to the average grain size of the screened formation) into the bottom of the borehole by using a tremie pipe. The primary filter pack is placed in increments as the tremie is gradually raised. The sand pack will be emplaced by the "washdown" gravity method and the depth to the top of the sand pack shall be determined and recorded frequently during the operation to ensure proper placement. The tremie pipe or a weighted line inserted through the tremie pipe can be used to measure the top of the primary filter pack as work progresses. As primary filter pack material is poured into the tremie pipe, potable water is used to help move the sand through the tremie pipe. The quantity of water introduced shall be recorded in a field logbook. If bridging of the primary filter pack occurs, the bridged material shall be broken mechanically before proceeding with the addition of more filter pack material. The depth, volume, and gradation of the primary filter pack will be recorded on the well construction diagram.

If used, temporary casing or auger sections will be withdrawn in increments as the sand pack is emplaced. Care shall be taken to minimize lifting the casing with the withdrawal of the temporary casing/augers. To limit borehole collapse, the temporary casing or hollow-stem auger is usually withdrawn until the lowermost point on the temporary casing or hollow-stem auger is at least 2 feet, but no more than 5 feet, above the filter pack for unconsolidated materials; or at least 5 feet, but no more than 10 feet, for consolidated materials. Ascertain the depth of the sand with an acceptable measuring device or with tremie pipe and verify the thickness of the sand pack. The primary filter pack is typically placed a minimum of 2 feet above the top of the well screen to account for settlement of the filter pack.

5.2.5 Installation of the Bentonite Seal

A minimum 2-foot-thick bentonite seal shall be emplaced on top of the filter pack or transition sand (if used) and is generally emplaced by gravity feed. The bentonite shall be slowly fed into the annulus and carefully monitored to ensure that bridging is not taking place. Time-release pellets coated with a food-grade coating must be used in deep well applications to prevent premature expansion of the bentonite.

Some clients may require installing the bentonite seal by using a tremie pipe. This type of installation shall be accomplished by washing the bentonite pellets through the tremie pipe with potable water. If the tremie pipe becomes plugged, requiring an increase in pressure to clear it, not less than 20 feet of tremie pipe shall be pulled up to avoid jetting into the sand pack. If the seal is installed above the water level, water shall be added to allow proper hydration of the annular seal (approximately 1 gallon for each linear foot of annular seal). The volume and depth of the bentonite seal material shall be measured and recorded on the well construction diagram.

5.2.6 Grouting the Annular Space

The following procedures apply to both single- and multi-cased monitoring wells. However, it shall be noted that grouting procedures will vary with the type of well design.

A sufficient volume of grout shall be premixed onsite, according to procedure stipulated by the manufacturer, to compensate for unexpected losses and checked against the known volume of annular space to ensure that bridging does not occur during emplacement. The use of alternate grout materials, including grout containing portland cement, may be necessary to control zones of high grout loss. The mixing (and placing) of grout shall be performed with recorded weights and volumes of materials, according to procedures stipulated by the manufacturer. Lumpy grout shall not be used in an effort to prevent bridging within the tremie and the well. Bentonite-based grout of Volclay or equivalent type shall be mixed to the manufacturer's specifications then pumped into place using minimum pump pressure. All additives to grouts shall be evaluated for their effects on subsequent water samples.

Depending upon the well design, grouting may be accomplished using a pressure grouting technique or by gravity feed through a tremie pipe. With either method, grout is introduced in one continuous operation until grout flows out at the ground surface without evidence of drill cuttings or fluid. The grout backfill shall be injected under pressure using a tremie pipe to reduce the possibility of leaving voids in the annular seal and to displace any liquids and drill cuttings that may remain in the annulus.

Grouting shall begin directly above the bentonite seal, after the bentonite has been adequately hydrated. Grout shall be injected using a tremie pipe. The tremie pipe shall be kept full of grout from start to finish with the discharge end of the pipe completely submerged as it is slowly and continuously lifted. Pump pressure shall be kept to a minimum. Approximately 5 to 10 feet of tremie pipe shall remain submerged during group emplacement. If possible, steel tape soundings shall be made to ensure the level of the tremie material is in agreement with the calculated volume and that the desired placement of annular materials is achieved. A staged grouting procedure may be considered if the couplings of the selected casing cannot withstand the shear or if there is collapse stress exerted by the full column of grout as it sets. If used, the temporary casing or hollow-stem auger shall be removed in increments (immediately following each lift of grout installation) well in advance of the time when the grout begins to set. The initial grout mixture must be allowed to cure for approximately 12 hours, then refilled to the surface.

The well casing shall not be developed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and casing. The amount of time required (generally 24 to 48 hours) will vary with grout content and climate conditions and shall be documented on the well completion diagram along with the volume and depth of grout used to backfill the annular space.

5.3 Well Protection

Well protection refers specifically to installations made at or above the ground surface to deter unauthorized entry to the monitoring well, prevent damage, and to prevent surface water from entering the annulus.

The protective casing shall extend from below the frost line (at least 2 feet below grade) to slightly above the well casing top. The protective casing shall be sealed and immobilized in concrete that has been placed around the outside of the protective casing above the set grout backfill. The casing shall be positioned and stabilized in a position concentric with the casing. Clearance (usually 6 inches) shall be maintained between the lid of the protective casing and the top of the casing to accommodate sampling equipment. A ¼-inch-diameter weep hole shall be drilled in the protective casing at the ground surface to permit water to drain out of the annular space. This hole will also prevent water freezing between the well protector and the well casing.

All materials used shall be documented on the well construction diagram. The monitoring well identification number shall be clearly visible on the inside and outside of the lid of the protective casing and the outside of the protective casing.

A 3-feet x 3-feet x 6-inch-thick concrete pad, sloped to provide water drainage away from the well, may be placed around the installation. Pad size may vary according to site conditions or client specifications. Three to four 2½-inch-diameter concrete-filled steel posts set at least 24 inches below the surface in concrete shall be equally spaced around the well to protect against damage by vehicular traffic for aboveground well completions. The protective casing and steel posts may be primed and painted with rust-resistant yellow paint. The annulus between the well casing and the protective casing may be filled with sand to approximately 1 foot below the top of the well casing to help stabilize the well casing and prevent the loss of tools or equipment in the annular space.

A flush-mounted, traffic-rated casing or vault is typically used for the surface completion of monitoring wells installed in high-use paved or maintained grass (landscaped) areas. The well box cover shall be finished slightly above pavement or ground surface to prevent water entry. A layer of sand or gravel material shall be placed under the casing/vault to allow infiltrating surface water to drain out.

5.4 Post Operation

5.4.1 Field

At the conclusion of the monitoring well installation activities, all equipment must be decontaminated (according to CDM Federal SOP 4-5) before moving the equipment to a different work location. All water used in the decontamination of drilling equipment will be contained in an appropriate container, if required in the site-specific plans.

5.4.2 Documentation

The Groundwater Monitoring Well Construction Form (Figures 1, 2, 3, and 4 or equivalent) shall be completed by the CDM FTL or designee at the conclusion of the field activity.

Copies of all field notes, the daily logs, and any completed Groundwater Monitoring Well Construction Forms shall be given to the site manager. These records shall be maintained in the project and document control files. At a minimum, all materials used for construction shall be documented by entering identifying numbers (lot numbers, manufacturer's identification, etc.) in the field logbook. Samples of well materials (including grout, sand, etc.) may be archived if specified in the project plans.

6.0 Restrictions and Limitations

None.

7.0 References

American Society for Testing and Materials. 2001. Designation: D 6725, *Standard Practice for Direct-Push Installation of PrePacked Screen Monitoring Wells in Unconsolidated Aquifers*, Rev. 1. November.

__________. 2004. Designation: D 5092, *Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers*, Rev. 4. June.

__________. 2004. Designation: D 6724, *Standard Guide for Installation of Direct-Push Groundwater Monitoring Wells*, Rev. 4. July.

Driscoll, F. G. 1986. *Groundwater and Wells*, 2nd Ed. Johnson Division. St. Paul, Minnesota.

U. S. Army Corps of Engineers. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites*, EM 1110-1-4000. November 1.

U. S. Department of Energy. 2001. Environmental Restoration Project. *Standard Operating Procedure for Well Construction*, ER2001-0381. April 27.

Figure 1

Typical Construction Detail of Above-Grade Single-Cased Monitor Well (Not to Scale - Shown as an Example Only)

MONITOR WELL CONSTRUCTION DETAILS

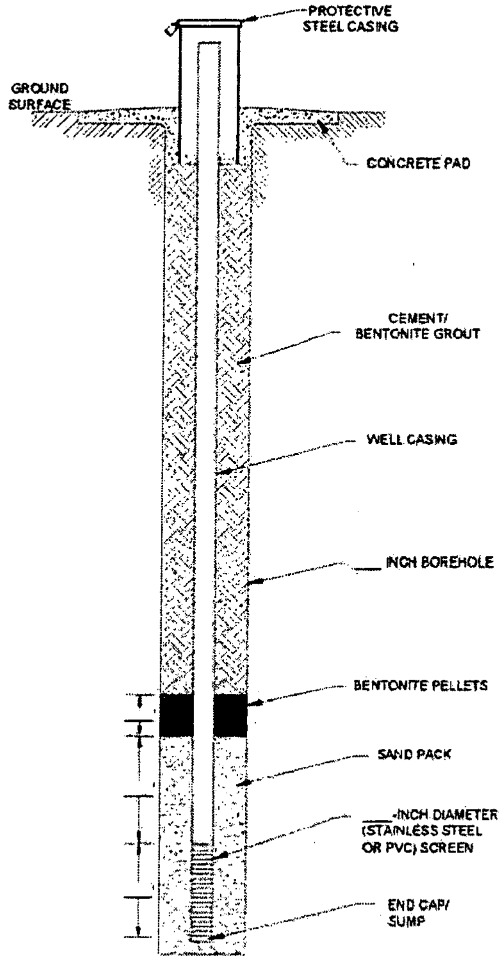
WELL NO. __________

BORING DATA
TOTAL DEPTH OF BOREHOLE __________
HOLE DIAMETER __________
DRILLING METHOD __________

CONSTRUCTION DATA
CASING LENGTH __________
CASING DIAMETER __________
CASING MATERIAL __________
JOINT DESIGN __________
SEAL __________
FILTER PACK __________
SCREEN SIZE __________
SCREEN MATERIAL __________

A. CASING ELEVATION ABOVE GROUND __________
B. DEPTH TO TOP OF CASING __________
C. DEPTH OF TOP OF GROUT __________
D. DEPTH TO TOP OF BENTONITE __________
E. DEPTH TO TOP OF SAND __________
F. DEPTH TO TOP OF SCREEN __________
G. TOTAL WELL DEPTH __________
H. WATER FIRST NOTICED __________
I. DEPTH TO WATER AT COMPLETION __________

CLIENT __________
DRILLING CONTRACTOR __________
DRILL RIG __________
DRILLERS __________
INSTALLATION DATE __________
LOGGED BY __________



NOT TO SCALE

Details of Monitoring Well __________
Project __________
Project Location __________

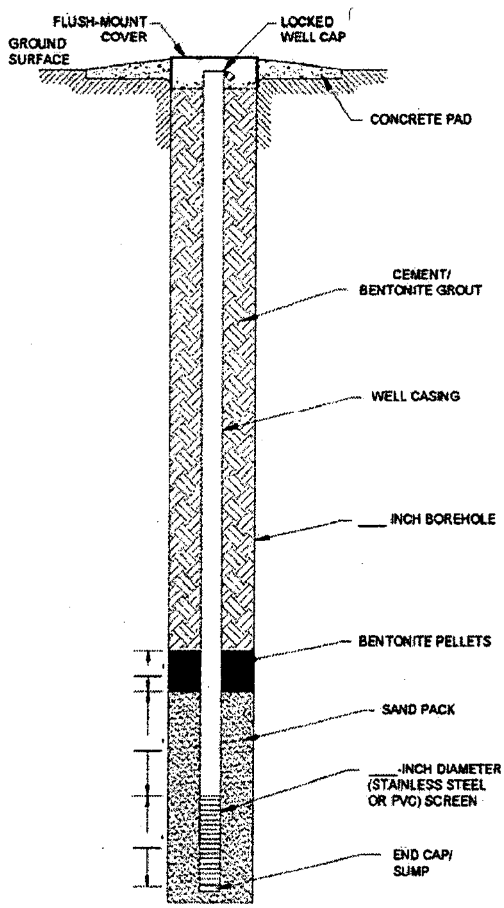
CDM

Figure 2

Typical Construction Detail of Flush-Mount Single-Cased Monitor Well
(Not to Scale - Shown as an Example Only)

MONITOR WELL CONSTRUCTION DETAILS

WELL NO. ____________



BORING DATA
TOTAL DEPTH OF BOREHOLE ____________
HOLE DIAMETER ____________
DRILLING METHOD ____________

CONSTRUCTION DATA
CASING LENGTH ____________
CASING DIAMETER ____________
CASING MATERIAL ____________
JOINT DESIGN ____________
SEAL ____________
FILTER PACK ____________
SCREEN SIZE ____________
SCREEN MATERIAL ____________

A. CASING ELEVATION ABOVE GROUND ____________
B. DEPTH TO TOP OF CASING ____________
C. DEPTH OF TOP OF GROUT ____________
D. DEPTH TO TOP OF FINE SAND ____________
E. DEPTH TO TOP OF SAND ____________
F. DEPTH TO TOP OF SCREEN ____________
G. TOTAL WELL DEPTH ____________
H. WATER FIRST NOTICED ____________
I. DEPTH TO WATER AT COMPLETION ____________

CLIENT ____________
DRILLING CONTRACTOR ____________
DRILL RIG ____________
DRILLERS ____________
INSTALLATION DATE ____________
LOGGED BY ____________

NOT TO SCALE

Details of Monitoring Well ____________
Project ____________
Project Location ____________

CDM

Figure 3

Typical Construction Detail of Above-Grade Double-Cased Monitor Well (Not to Scale - Shown as an Example Only)

MONITOR WELL CONSTRUCTION DETAILS

WELL NO. ________

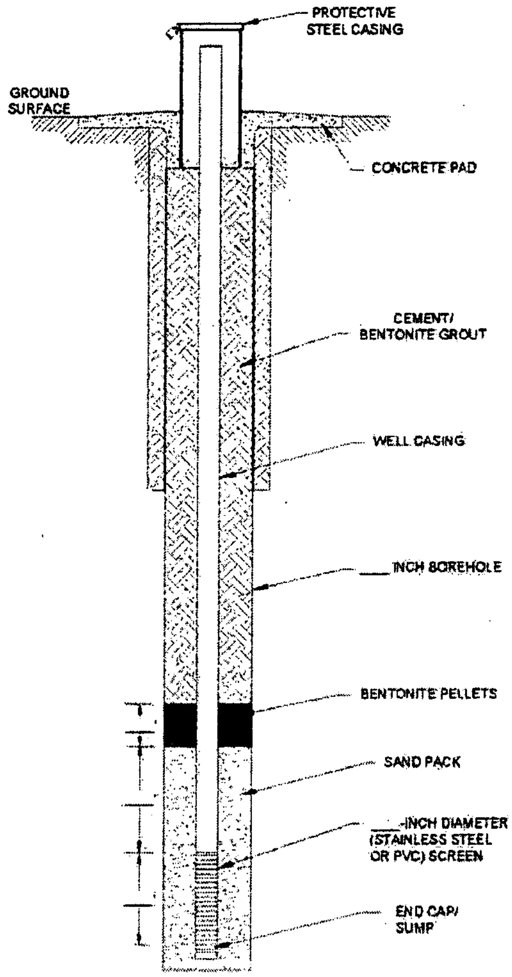
BORING DATA
TOTAL DEPTH OF BOREHOLE ________
HOLE DIAMETERS ________
DRILLING METHOD(S) ________

SURFACE CASING
DEPTH TO BEDROCK ________
TOTAL DEPTH OF CASING ________
CASING DIAMETER ________
CASING MATERIAL ________

CONSTRUCTION DATA
CASING LENGTH ________
CASING DIAMETER ________
CASING MATERIAL ________
JOINT DESIGN ________
SEAL ________
FILTER PACK ________
SCREEN SIZE ________
SCREEN MATERIAL ________

A. CASING ELEVATION ABOVE GROUND ________
B. DEPTH TO TOP OF CASING ________
C. DEPTH OF TOP OF GROUT ________
D. DEPTH TO TOP OF BENTONITE ________
E. DEPTH TO TOP OF SAND ________
F. DEPTH TO TOP OF SCREEN ________
G. TOTAL WELL DEPTH ________
H. WATER FIRST NOTICED ________
I. DEPTH TO WATER AT COMPLETION ________

CLIENT ________
DRILLING CONTRACTOR ________
DRILL RIG ________
DRILLERS ________
INSTALLATION DATE ________
LOGGED BY ________



NOT TO SCALE

Details of Monitoring Well ________
Project ________
Project Location ________

CDM

Figure 4

Typical Construction Detail of Flush-Mount Double-Cased Monitor Well (Not to Scale - Shown as an Example Only)

MONITOR WELL CONSTRUCTION DETAILS

WELL NO. ________

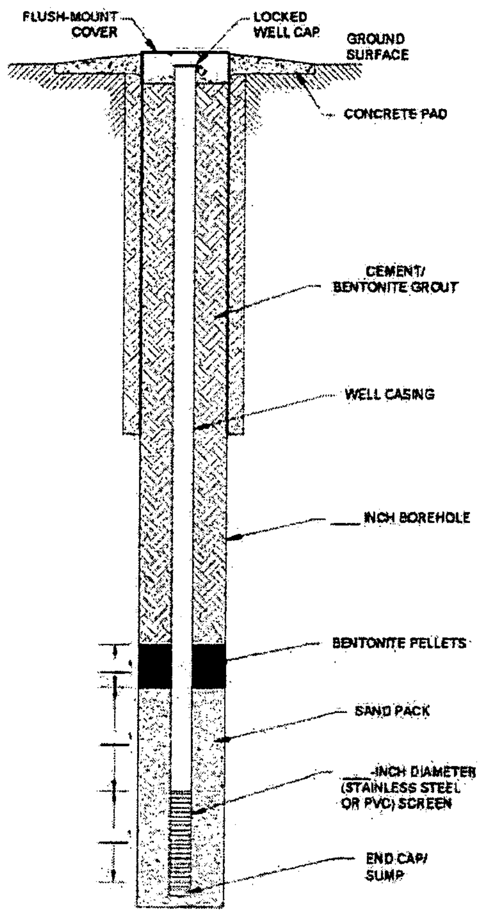
BORING DATA
TOTAL DEPTH OF BOREHOLE ________
HOLE DIAMETERS ________
DRILLING METHOD(S) ________

SURFACE CASING
DEPTH TO BEDROCK ________
TOTAL DEPTH OF CASING ________
CASING DIAMETER ________
CASING MATERIAL ________

CONSTRUCTION DATA
CASING LENGTH ________
CASING DIAMETER ________
CASING MATERIAL ________
JOINT DESIGN ________
SEAL ________
FILTER PACK ________
SCREEN SIZE ________
SCREEN MATERIAL ________

A. CASING ELEVATION ABOVE GROUND ________
B. DEPTH TO TOP OF CASING ________
C. DEPTH OF TOP OF GROUT ________
D. DEPTH TO TOP OF BENTONITE ________
E. DEPTH TO TOP OF SAND ________
F. DEPTH TO TOP OF SCREEN ________
G. TOTAL WELL DEPTH ________
H. WATER FIRST NOTICED ________
I. DEPTH TO WATER AT COMPLETION ________

CLIENT ________
DRILLING CONTRACTOR ________
DRILL RIG ________
DRILLERS ________
INSTALLATION DATE ________
LOGGED BY ________



NOT TO SCALE

Details of Monitoring Well ________
Project ________
Project Location ________

CDM

TSOP 4-5

FIELD EQUIPMENT DECONTAMINATION AT NONRADIOACTIVE SITES

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 4-5
Revision: 4
Date: March 7, 2003

SOP Title: FIELD EQUIPMENT DECONTAMINATION AT NON-RADIOACTIVE SITES

E-Signed by Jeniffer Oxford
VERIFY authenticity with Approve

QA Review: J Oxford

E-Signed by Jeanne Litwin
VERIFY authenticity with Approve

Approved and Issued: J Litwin
Program Manager Signature/Date

Contract No.: RAC II Client: USEPA, Region II

Reason for Clarification: Make SOP USEPA Region II – Specific

Clarification (attach additional sheets if necessary; state section and page numbers when applicable):

4.0 REQUIRED EQUIPMENT, add (to page 2 of 9):

- Respirator Sanitizer

Replace reference to ASTM Type II water with demonstrated analyte-free water.

5.0 PROCEDURES

5.1 Heavy Equipment Decontamination, add:

All drilling equipment that comes in contact with the soil must be steam cleaned before use and between boreholes. This includes drill rods, bits and augers, dredges or any other large piece of equipment.

5.2 Downhole Equipment Decontamination, add (on page 4 of 9):

All drilling equipment that comes in contact with the soil must be steam cleaned before use and between boreholes. This includes drill rods, bits, dredges or any other large piece of equipment.

Well casings must be steam cleaned prior to installation to ensure that all oils, greases, and waxes have been removed. Because of the softness of casings and screens made of fluorocarbon resins, these materials should be detergent washed, not steam cleaned prior to installation. They should be rested on clean polyethylene sheeting to keep the possibility of contamination to a minimum.

5.3 Sampling Equipment Decontamination, replace (beginning on page 5 of 9) with:

Sampling equipment includes such items as split spoons that directly sample media. Follow these steps when decontaminating this equipment.

1. Set up a decontamination line on plastic sheeting. The decontamination line should progress from "dirty" to "clean" and have an area located upwind for drying decontaminated equipments At a minimum, clean plastic sheeting must be used to cover the ground, tables, or the surfaces on which decontaminated equipment is to be placed for drying.

2. Before washing, disassemble any items that might trap contaminants internally. Do not reassemble these items until decontamination and air drying are complete. Wash items thoroughly in a bucket of low phosphate detergent and potable water. Use a stiff-bristle brush to dislodge any gross contamination (soil or debris).

3. Rinse the items in tap water. Tap water may be used from any municipal water treatment system. The Use of an untreated potable water supply is not an acceptable substitute. Rinse water should be placed as needed, generally when cloudy.

4. Rinse the item with 10% nitric acid prepared from ultra pure grade (for stainless steel, glass, plastic, and Teflon®) or 1% nitric acid prepared from ultrapure grade (for carbon steel implements, such as split spoons). This rinse is required when sampling for inorganics.

5. Rinse item in de-ionized water.

6. Rinse item in acetone. All solvents must be pesticide grade or better. The solvent rinse is only required when sampling for organics.

   If required by the field plan, when sampling for polar organic compounds such as pesticides, polychlorinated biphenyls (PCBs), and fuels, rinse the item with hexane or approved alternatives, followed by a second methanol rinse.

7. Rinse item in demonstrated analyte-free water. The amount of water must be at least five times that of the solvent used in step 6 or 7.

   A sample of demonstrated analyte-free water will be collected and submitted for chemical analysis. Analytical results will be kept on-site. Determination of analyte-free water will be according to the *Region II CERCLA Quality Assurance Manual* (October 1989 revision, page 59).

8. Allow the item to air dry completely.

9. After drying, wrap in aluminum foil, shiny side out, for transport.

10. After decontamination activities are complete, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable gloves, boots, and clothing. Place contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately. (Refer to site-specific plans for labeling and waste management requirements).

5.4 Pump Decontamination

Substitute (on Page 7 of 9) references to ASTM Type II water with demonstrated analyte-free water.

5.5 Instrument Probe Decontamination

Substitute (on page 7 of 9) references to ASTM Type II water with de-ionized water.

Add subsection on:

PERSONAL PROTECTION EQUIPMENT DECONTAMINATION

This decontamination procedure applies to personal protective equipment that is not disposable, such as respirators or overboots.

1. Rinse item in non-residual detergent (Alconox).

2. Apply respirator sanitizer. This step only applies to respirator decontamination.

3. Rinse item in potable water.

4. Allow the item to air dry.

6.0 RESTRICTIONS/LIMITATIONS, add (on page 8 of 9):

While performing decontamination activities, phthalate-free gloves should be used to prevent phthalate contamination of the sampling equipment that could result from the interaction of the gloves with the organic solvents.

Field Equipment Decontamination at Nonradioactive Sites

SOP 4-5
Revision: 7
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Technical Review: Mike Higman

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1.0 Objective

The objective of this standard operating procedure (SOP) is to describe the general procedures required for decontamination of field equipment at nonradioactive sites. This SOP serves as a general guide and is applicable at most sites; however, it shall be noted that site-specific conditions (i.e., type of contamination, type of media sampled), the governing agency (e.g., EPA, DOE, USACE), and site-specific work plans, sampling and analysis plans and/or quality assurance (QA) project plans may require modifications to the decontamination procedures provided in this SOP. Decontamination of field equipment is necessary to ensure acceptable quality of samples by preventing cross contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants offsite.

2.0 Background

2.1 Definitions

Acid Rinse - A solution of 10 percent nitric or hydrochloric acid made from reagent grade acid and analyte-free water.

Analyte-Free Water - Tap water that has been treated so that the water contains no detectable heavy metals or other inorganic compounds. Analyte-free water shall be stored only in clean glass, stainless steel, or plastic containers that can be closed when not in use.

Clean - Free of contamination and when decontamination has been completed in accordance with this SOP.

Cross Contamination - The transfer of contaminants through equipment or personnel from the contamination source to less contaminated or noncontaminated samples or areas.

Decontamination - The process of rinsing or otherwise cleaning the surfaces of equipment to rid them of contaminants and to minimize the potential for cross contamination of samples or exposure of personnel.

Material Safety Data Sheets (MSDS) - These documents discuss the proper storage and physical and toxicological characteristics of a particular substance used during decontamination. These documents, generally included in site health and safety plans, shall be kept on site at all times during field operations.

Organic-Free/Analyte-Free Water - Tap water that has been treated so that the water meets the analyte-free water criteria and contains no detectable organic compounds. Organic-free/analyte-free water shall be stored only in clean glass, Teflon™, or stainless steel containers that can be closed when not in use.

Potable Water - Tap water may be obtained from any municipal system. Chemical analysis of the water source may be required before it is used.

Sampling Equipment - Equipment that comes into direct contact with the sample media. Such equipment includes split spoon samplers, well casing and screens, and spatulas or bowls used to homogenize samples.

Soap - Low-sudsing, nonphosphate detergent such as Liquinox™.

Solvent Rinse - Pesticide grade, or better, isopropanol, acetone, or methanol.

2.2 Associated Procedures

- CDM Federal SOP 1-1 - *Surface Water Sampling*
- CDM Federal SOP 1-3 - *Surface Soil Sampling*
- CDM Federal SOP 1-4 - *Subsurface Soil Sampling*
- CDM Federal SOP 1-5 - *Groundwater Sampling Using Bailers*
- CDM Federal SOP 1-7 - *Wipe Sampling*
- CDM Federal SOP 1-9 - *Tap Water Sampling*
- CDM Federal SOP 1-11 - *Sediment/Sludge Sampling*
- CDM Federal SOP 2-2 - *Guide to Handling Investigation-Derived Waste*
- CDM Federal SOP 3-1 - *Geoprobe® Sampling*

3.0 Responsibilities

The project manager or designee, generally the field team leader (FTL), ensures that field personnel are trained in the performance of this procedure and that decontamination is conducted in accordance with this SOP and site-specific work plans. The FTL may also be required to collect and document rinsate samples (also known as equipment blanks) to provide quantitative verification that these procedures have been correctly implemented.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific QA plan.

4.0 Required Equipment

- Stiff-bristle scrub brushes
- Plastic buckets and troughs
- Soap
- Nalgene or Teflon sprayers or wash bottles or 2- to 5-gallon, manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Plastic sheeting, plastic bags, and/or aluminum foil to keep decontaminated equipment clean between uses
- Disposable wipes, rags, or paper towels
- Potable water*
- Analyte-free water
- Organic-free/analyte-free water
- Gloves, safety glasses, and other protective clothing as specified in the site-specific health and safety plan
- High-pressure pump with soap dispenser or steam-spray unit (for large equipment only)
- Appropriate decontamination solutions pesticide grade or better and traceable to a source (e.g., 10 percent and/or 1 percent nitric acid [HNO_3], acetone, methanol, isopropanol, hexane)
- Tools for equipment assembly and disassembly (as required)
- 55-gallon drums or tanks for temporary storage of decontamination water (as required)
- Pallets for drums or tanks holding decontamination water (as required)

* Potable water may be required to be tested for contaminants before use. Check field plan for requirements.

5.0 Procedures

All reusable equipment (nondedicated) used to collect, handle, or measure samples shall be decontaminated before coming into contact with any sampled media or personnel using the equipment. Decontamination of equipment shall occur either at a central decontamination station or at portable decontamination stations set up at the sampling location, drill site, or monitoring well location. The centrally located decontamination station shall include an appropriately sized bermed and lined area on which equipment decontamination shall occur and shall be equipped with a collection system and storage vessels. In certain circumstances, berming is not required when small quantities of water are being generated and for some short duration field activities (i.e., pre-remedial sampling). Equipment shall be transported to and from the decontamination station in a manner to prevent cross contamination of equipment and/or area. Precautions taken may include enclosing augers in plastic wrap while being transported on a flatbed truck.

The decontamination area shall be constructed so that contaminated water is either collected directly into appropriate containers (5-gallon buckets or steel wash tubs) or within the berms of the decontamination area that then drains into a collection system. Water from the collection system shall be transferred into 55-gallon drums or portable tanks for temporary storage. Typically, decontamination water shall be staged until sampling results or waste characterization results are obtained and evaluated and the proper disposition of the waste is determined (SOP 2-2, *Guide to Handling Investigation-Derived Waste*). The exact procedure for decontamination waste disposal shall be discussed in the work plan. Also, solvent and acid rinse fluids may need to be segregated from other investigation-derived wastes.

All items that shall come into contact with potentially contaminated media shall be decontaminated before use and between sampling and/or drilling locations. If decontaminated items are not immediately used, they shall be covered either with clean plastic or aluminum foil depending on the size of the item. All decontamination procedures for the equipment being used are as follows:

General Guidelines

- Potable, analyte-free, and organic-free/analyte-free water shall be free of all contaminants of concern. Following the field QA sampling procedure described in the work plan, analytical data from the water source may be required.
- Sampling equipment that has come into contact with oil and grease shall be cleaned with methanol or other approved alternative to remove the oily material. This may be followed by a hexane rinse and then another methanol rinse. Regulatory or client requirements regarding solvent use shall be stated in the work plan.
- All solvents and acids shall be pesticide grade or better and traceable to a source. The corresponding lot numbers shall be recorded in the appropriate logbook.

  Note: Solvents and acids are potentially hazardous materials and must be handled, stored, and transported accordingly. Solvents shall never be used in a closed building. See the site-specific health and safety plan and/or the chemical's MSDS for specific information regarding the safe use of the chemical.
- Decontaminated equipment shall be allowed to air dry before being used.
- Documentation of all cleaning and field QA sampling shall be recorded in the appropriate logbook.
- Gloves, boots, safety glasses, and any other personnel protective clothing and equipment shall be used as specified in the site-specific health and safety plan.

5.1 Heavy Equipment Decontamination

Heavy equipment includes drilling rigs, well development rigs, and backhoes. Follow these steps when decontaminating this equipment:

- Establish a bermed decontamination area that is large enough to fully contain the equipment to be cleaned. If available, an existing wash pad or appropriate paved and bermed area may be used; otherwise, use one or more layers of heavy plastic sheeting to cover the ground surface and berms. All decontamination pads shall be upwind of the area under investigation.
- With the rig in place, spray areas (rear of rig or backhoe) exposed to contaminated media using a hot water high-pressure sprayer. Be sure to spray down all surfaces, including the undercarriage.
- Use brushes, soap, and potable water to remove dirt whenever necessary.
- Remove equipment from the decontamination pad and allow it to air dry before returning it to the work site.
- Record the equipment type, date, time, and method of decontamination in the appropriate logbook.

- After decontamination activities are completed, collect all contaminated wastewater, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal as detailed in the field plan. Liquids and solids must be drummed separately.

5.2 Downhole Equipment Decontamination

Downhole equipment includes hollow-stem augers, drill pipes, rods, stems, etc. Follow these steps when decontaminating this equipment:

- Set up a centralized decontamination area, if possible. This area shall be set up to collect contaminated rinse waters and to minimize the spread of airborne spray.
- Set up a "clean" area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed. All decontamination pads shall be upwind of any areas under investigation.
- Place the object to be cleaned on aluminum foil or plastic-covered wooden sawhorses or other supports. The objects to be cleaned shall be at least 2 feet above the ground to avoid splashback when decontaminating.
- Using soap and potable water in the hot water high-pressure sprayer (or steam unit), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.
- If using soapy water, rinse the equipment using clean, potable water. If using hot water, the rinse step is not necessary if the hot water does not contain a detergent. If the hot water contains a detergent, this final clean water rinse is required.
- Using a suitable sprayer, rinse the equipment thoroughly with analyte-free water.
- Remove the equipment from the decontamination area and place in a clean area upwind to air dry.
- Record equipment type, date, time, and method of decontamination in the appropriate logbook.
- After decontamination activities are completed, collect all contaminated wastewaters, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal. Liquids and solids must be drummed separately.

5.3 Sampling Equipment Decontamination

Follow these steps when decontaminating sampling equipment:

- Set up a decontamination line on plastic sheeting. The decontamination line shall progress from "dirty" to "clean." A clean area shall be established upwind of the decontamination wash/rinse activities to dry the equipment. At a minimum, clean plastic sheeting must be used to cover the ground, table, or other surfaces that the decontaminated equipment is placed for drying.
- Disassemble any items that may trap contaminants internally. Do not reassemble the items until decontamination and air drying are complete.
- Wash the items with potable water and soap using a stiff brush as necessary to remove particulate matter and surface films. The items may be steam cleaned using soap and hot water as an alternative to brushing. ***Note*****: Polyvinyl chloride or plastic items shall not be steam cleaned.** Items that have come into contact with concentrated and/or oily contaminants may need to be rinsed with a solvent such as hexane and allowed to air dry prior to this washing step.
- Thoroughly rinse the items with potable water.

- If sampling for metals, thoroughly rinse the items with an acid solution (e.g., 10 percent nitric acid) followed by a rinse using analyte-free water. If sampling for organic compounds, thoroughly rinse the items with solvent (e.g., isopropanol) followed by a rinse using analyte-free water. The specific chemicals used for the acid rinse and solvent rinse phases shall be specified in the work plan. The acid rinsate and solvent rinsate must each be containerized separately. Acids and solvents are potentially hazardous materials and care must be exercised when using these chemicals to prevent adverse health affects (e.g., skin burns, irritation to the eyes and respiratory system). Appropriate personal protective equipment must be worn when using these chemicals. These chemicals (including spent rinsate) must be managed and stored appropriately. Special measures such as proper labels, paperwork, notification, etc. may be required when transporting or shipping these chemicals.
- Rinse the items thoroughly using organic-free/analyte-free water.
- Allow the items to air dry completely.
- After drying, reassemble the parts as necessary and wrap the items in clean plastic wrap or in aluminum foil.
- Record equipment type, date, time, and method of decontamination in the appropriate logbook.
- After decontamination activities are completed, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable personal protective equipment. Place the contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately. Refer to site-specific plans for labeling and waste management requirements.

5.4 Pump Decontamination

Follow the manufacturer's recommendation for specified pump decontamination procedures. At a minimum, follow these steps when decontaminating pumps:

- Set up the decontamination area and separate "clean" storage area using plastic sheeting to cover the ground, tables, and other surfaces. Set up four containers: the first container shall contain dilute (nonfoaming) soapy water, the second container shall contain potable water, the third container shall be empty to receive wastewater, and the fourth container shall contain analyte-free water.
- The pump shall be set up in the same configuration as for sampling. Submerge the pump intake (or the pump, if submersible) and all downhole-wetted parts (tubing, piping, foot valve) in the soapy water of the first container. Place the discharge outlet in the wastewater container above the level of the wastewater. Pump soapy water through the pump assembly until it discharges to the waste container. Scrub the outside of the pump and other wetted parts with a metal brush.
- Move the pump assembly to the potable water container while leaving discharge outlet in the waste container. All downhole-wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.
- Move the pump intake to the analyte-free water container. Pump the water through the pump assembly. Pump the volume of water through the pump specified in the field plan. Usually, three pump-and-line-assembly volumes shall be required.
- Decontaminate the discharge outlet by hand, following the steps outlined in Section 5.3.
- Remove the decontaminated pump assembly to the clean area and allow it to air dry upwind of the decontamination area. Intake and outlet orifices shall be covered with aluminum foil to prevent the entry of airborne contaminants and particles.
- Record the equipment type, serial number, date, time, and method of decontamination in the appropriate logbook.

5.5 Instrument Probe Decontamination
Instrument probes used for field measurements such as pH meters, conductivity meters, etc. shall be decontaminated between samples and after use with analyte-free, or better, water.

5.6 Waste Disposal
Refer to site-specific plans and SOP 2-2 for waste disposal requirements. The following are guidelines for disposing of wastes:

- All wash water, rinse water, and decontamination solutions that have come in contact with contaminated equipment are to be handled, packaged, labeled, marked, stored, and disposed of as investigation-derived waste.
- Small quantities of decontamination solutions may be allowed to evaporate to dryness.
- If large quantities of used decontamination solutions shall be generated, each type of waste shall be contained in separate containers.
- Unless otherwise required, plastic sheeting and disposable protective clothing may be treated as solid, nonhazardous waste.
- Waste liquids shall be sampled, analyzed for contaminants of concern in accordance with disposal regulations, and disposed of accordingly.

6.0 Restrictions/Limitations
Nitric acid and polar solvent rinses are necessary only when sampling for metals or organics, respectively. These steps shall not be used, unless required, because of the potential for acid burns and ignitability hazards.

If the field equipment is not thoroughly rinsed and allowed to completely air dry before use, volatile organic residue, which interferes with the analysis, may be detected in the samples. The occurrence of residual organic solvents is often dependent on the time of year sampling is conducted. In the summer, volatilization is rapid, and in the winter, volatilization is slow. Check with your EPA region, state, and client for approved decontamination solvents.

7.0 References
American Society for Testing and Materials. 2002. *Standard Practice for Decontamination of Field Equipment at Nonradioactive Waste Sites*, ASTM D5088-02. January 10.

Department of Energy. Hazardous Waste Remedial Actions Program. 1996. *Standard Operating Procedures for Site Characterization*, DOE/HWP-100/R1. September.

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U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.1.

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TSOP 4-8

ENVIRONMENTAL DATA MANAGEMENT

Environmental Data Management

SOP 4-8
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1.0 Objective

The objective of this standard operating procedure (SOP) is to provide instruction to data managers, technical staff, and project managers in preparing an environmental project data management plan. The data management plan identifies and documents a project's requirements and responsibilities for managing and using environmental information. Details determined and provided in the data management plan must clearly define:

- Data types the project will generate and use
- Responsibilities for activities associated with information management
- How the project data will be managed
- When data transfers will occur and who will provide and receive data

Additionally, this SOP defines the technical approach for data management activities associated with the collection and analysis of environmental data.

2.0 Background

The data management plan must be completed at the beginning of the project lifecycle. This ensures that the necessary environmental data management systems and personnel are identified and in place before the initiation of data collection. Reviews and updates of the data management plan must also be completed as necessary.

The data management plan only addresses the management of a project's environmental information. Environmental information includes electronic and hardcopy records that document environmental processes and conditions and are used to support the project objectives related to environmental and remedial decisions. Information generated by the project activities (e.g., chemical, physical) and information obtained from outside sources (e.g., historical data) are managed within the scope of the data management plan. Information such as human resources and financial records are not within the scope of the data management plan.

Project managers, technical staff, and data coordinators have the responsibility for developing the data management plan. Additional staff (e.g., field team leaders, data users) shall also be involved in the data management plan generation as necessary. The minimum project data requirements will depend on the statement of work for individual projects. The project team shall work together to identify project data management requirements, define the environmental data collection and handling process, and define the project data management responsibilities. The process to generate a data management plan is provided in Section 4.0.

2.1 Associated Procedures

All SOPs used to collect environmental data are subject to the procedures and processes presented in this SOP. These include:

- CDM Federal SOP 1-1, *Surface Water Sampling*
- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 1-3, *Surface Soil Sampling*
- CDM Federal SOP 1-4, *Subsurface Soil Sampling*

- CDM Federal SOP 1-5, *Groundwater Sampling Using Bailers*
- CDM Federal SOP 1-6, *Water Level Measurement*
- CDM Federal SOP 1-7, *Wipe Sampling*
- CDM Federal SOP 1-8, *Volatile Organic Compound Air Sampling Using USEPA Method TO-15 with SUMMA® Canister*
- CDM Federal SOP 1-9, *Tap Water Sampling*
- CDM Federal SOP 1-10, *Field Measurement of Organic Vapors*
- CDM Federal SOP 1-11, *Sediment/Sludge Sampling*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 3-1, *Geoprobe Sampling*
- CDM Federal SOP 3-2, *Topographic Survey*
- CDM Federal SOP 3-4, *Geophysical Logging, Calibration, and Quality Control*
- CDM Federal SOP 3-5, *Lithologic Logging*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-3, *Well Development and Purging*
- CDM Federal SOP 4-4, *Design and Installation of Monitoring Wells in Aquifers*
- CDM Federal SOP 4-6, *Hydraulic Conductivity Testing*

3.0 General Roles and Responsibilities

A general description of roles and responsibilities associated with environmental data management is provided below. It shall be understood that not all roles listed below will be required on all projects and that one person may perform multiple roles.

Project Manager - The project manager has the overall responsibility for completing the project. With respect to data management, this involves directing the project team in identifying existing sources of data, identifying the specific project study parameters (e.g., scope of the project), and selecting an effective data collection approach. Additionally, the project manager ensures that data management requirements are effectively communicated in subcontractor statements of work.

Technical Leader - The technical leader serves as the single point of contact for technical issues. This person provides support during the planning, implementation, and reporting of the project.

Project Team - The project team consists of technical and support staff (e.g., data management and administrative staff) who completes various tasks on the project. The project team is responsible for the development of requirement documents (e.g., sampling plans) and ensuring that client contractual requirements are met.

Field Team Leader - The field team leader supervises field teams during planning and implementation of field data collection. The field team leader ensures that field activities are documented according to project-specific requirements, reviewed as required, and that deviations are tracked and justified.

Field Team - The field team consists of individuals who perform activities detailed in the project-specific requirement documents. Field team responsibilities include recording field activities and information as required by the project-specific planning documents. Quality assurance reviews of procedure implementation are completed by a qualified field team member. Quality assurance reviews include ensuring samples are collected as required, calibrations are completed correctly, and that all information is recorded as required.

Data Management Team - The data management team consists of a data manager and data support staff. The data manager is responsible for developing and implementing the project data management plan and ensuring that requirements specified in the data management plan are met. The data manager ensures that existing data and new data generated during the course of the project are incorporated into the project files and applicable databases. The data manager also identifies and obtains appropriate data management training for the project team. The data manager is responsible for overseeing the data support staff.

Data support staff are responsible for entering environmental project data into the project files or database and ensuring that all information is entered accurately. Data support staff also work with the field teams and data users to ensure that data collection is complete and access to the data is appropriate.

Laboratory Coordinator - The laboratory coordinator develops the project-specific analytical statement of work. Analytical methods, detection limits, laboratory quality control requirements, and deliverable requirements must be detailed in the statement of work. The laboratory coordinator also communicates with the data manager to ensure that hardcopy and electronic deliverable formats are specified and meet project requirements.

Data Validation Coordinator - The data validation coordinator is responsible for developing the data validation process specific to the project requirements and is responsible for supervising data validation staff. Included in this process is the approach to verifying that analytical data and field data are complete and accurate, have fulfilled the requested analyses, and are in concurrence with the contract requirements. If discrepancies arise, the data validation coordinator interfaces with the laboratory for resolution. If data validation occurs via a subcontractor, the data validation coordinator is responsible for the development of the subcontractor statement of work and supervision and review of the subcontractor's work.

Data validation staff are responsible for ensuring that analytical data and field data are accurate according to a project-specific set of criteria, including the evaluation of quality control samples to ensure analyses are performed within specified control limits. All validation issues must be identified and corrected. Qualifiers may be assigned to the data to indicate concerns about usability.

Data User - Data users are members of the project team who require access to project information for project decisions and to prepare deliverables. The data user is responsible for documenting information used (e.g., geographic information system [GIS] coverage, database queries, statistical analysis completed) to generate any data deliverables (e.g., data tables, maps). This requirement ensures that deliverables may be reproduced in the future using an identical process. Additionally, the data user is responsible for determining whether or not the data used meet their specific usability requirements.

Note: Responsibilities may vary from site to site. Therefore, all team member responsibilities shall be defined in a work plan or site-/project-specific quality assurance project plan (QAPP).

4.0 Data Management Plan

This section describes the process to complete preparation of a project data management plan. The data management plan must be completed early in the life cycle of a project to ensure that the necessary and appropriate data management systems and personnel are identified and in place before a project begins to generate data. The data management plan identifies and documents the project requirements and responsibilities for managing and using environmental information. The data management plan must provide enough detail to clearly define:

- The types of data the project will generate and use
- Responsibilities for information management activities and procedures to follow
- How the project will manage its data
- When data transfers will occur and who will provide and receive data

4.1 Data Management Plan Outline

The project manager, data manager, and technical leader will evaluate project and client requirements to prepare the data management plan. The following outline shall be customized to meet the project-specific requirements. Additionally, as the project evolves over time, the data management plan must be reviewed and updated periodically to ensure that it suitably meets modifications to the project requirements.

Section 1 - Introduction

- Briefly describe project objectives
- Briefly describe data quality and management objectives
- Briefly describe data management plan objectives and organization
- Summarize the types of data required by the project
- Summarize the data management activities

Section 2 - Data Sources and Needs
- Identify the project data needs (e.g., internal sources, external sources)
- Identify data collection formats (e.g., field forms to be used, GIS coverage)

Section 3 - Data Management Team Organization
- Present roles and responsibilities
- Identify lines of communication

Section 4 - Data Management Activities
- Project planning and setup and data flow process (e.g., sample locations and identification nomenclature, laboratory subcontracting)
- Field data collection (e.g., sample tracking, field data entry, historical data)
- Data validation, evaluation, and qualification
- Database entry and post qualification
- Data analysis and output (e.g., mapping format and specifications, data sharing, figure generation)
- Data quality assurance and quality control
- Data usability

Section 5 - Data Management and Geographic Information System and Process Administration
- Identify project data management and geographic information systems to be used
- Identify any project-specific systems to be used for analysis, modeling, or mapping
- Describe how the project will ensure that data, geographic, and analysis systems and processes are controlled (e.g., configuration change control, security)
- Project documentation and storage (records management)
- Quality control implementation (e.g., quality control of electronic documents, GIS software guidelines, other analytical software guidelines)

4.2 Data Management Plan Preparation

Data management plan development includes a seven-step process. Each of the steps involved in the process are annotated below. Critical issues of the data management plan are the definition of project activities, roles, and responsibilities related to data management.

- **Determine the Data Manager** - Every project must have a project data manager. The data manager is responsible for assisting in identification of data management and data record needs according to project and client requirements. The data manager will work with the project technical leader in the development of the data management plan.

- **Identify the Project Data Needs and Sources** - The data needs and sources will be determined during project scoping meetings and by discussions with the project team. The data types, sources, and uses must be considered when requirements are being defined. Identification of data types includes topics such as:

  - Maps
  - Field measurements
  - Inspection information
  - Sample media
  - Analyses
  - Locations
  - Quantity of samples
  - Quality for intended use
  - Observations

  Data source considerations will include historical, project-generated, and other similar projects. Examples of data uses include modeling (contaminant contouring/transport, geospatial), regulatory compliance, remedial investigation, and risk assessment.

- **Identify Existing Database Requirements** - A requirement may exist that all project information shall be transferred into a pre-existing client database. Close coordination with the client data managers and review of guidance will provide information associated with specific requirements. These requirements will include specific data loading tools, submission file groupings, and data entry guidance.

- **Identify Records Management Requirements** - The project manager, data manager, and technical leader will identify the records management requirements. Additionally, they will identify the types and quantities of records that will be generated and determine what requirements are necessary for their transmittal to the client or central storage location. Records will consist of the guidance and planning documents (sampling plan, quality assurance plan) that detail how samples and data are collected, processed, evaluated, and used by the project.

- **Define Data Management Activities and Responsibilities** - This step details the data flow process for the project. Within this process, responsibilities for data collection, data transfer, updates, and maintenance are defined. A clear understanding of these responsibilities is critical to ensure that the technical activities of the project are completed efficiently and effectively. Section 5.0 of this procedure provides generic activity descriptions and responsibilities common to many environmental projects.

  The data flow process must be reviewed by the project team to ensure completeness and project specificity. Small projects may allow one individual to complete several roles and responsibilities whereas large projects may require multiple personnel to complete one role. Project team understanding and comprehension of the activities and responsibilities are important to the efficient implementation of the overall data management program.

- **Determine Database Needs** - The project manager, data manager, and technical leader will determine the database needs and requirements. Project components to consider during this process are the complexity, types, and volume of data the project will generate; types, frequency, and detail of reports required; and required accessibility of the data. Based on these components and any other project requirements, a database need will be determined. Automation of the database shall also be considered during this step. Database automation consideration shall include factors such as:

  - Volume of data
  - Frequency that data will be received
  - Format of the received data (electronic or hardcopy)
  - Time constraints on data reports
  - Complexity of the data

  After database needs have been determined, the project manager and data manager will identify appropriate personnel to support the data management process. Personnel identification support can include geographical information system specialists, laboratory coordinators, and data support staff. Additionally, the project manager and data manager must identify any training requirement appropriate to the project data management process.

- **Prepare the Data Management Plan** - Based on the decisions made in the preceding steps and the customized outline, the data manager and technical leader will prepare the data management plan.

5.0 Project Data Management Activities

This section identifies typical environmental data management activities in the context of a generic project lifecycle. It is unlikely that all activities presented will be implemented on a single project. Only activities applicable to project-specific data management requirements need to be implemented. The activities presented below have been grouped into three sections. Section 5.1 presents planning activities that will identify the project data needs, identify existing information, plan for project data collection, and identify data management requirements. Section 5.2 presents data collection activities, which include data management support that will provide for efficient field data and field sample collection, data processing, and reporting. Section 5.3 provides review and data use activities that include the evaluation of data quality and project reporting.

5.1 Planning Activities

Environmental projects are most commonly conducted to determine contaminant characterization, remedial design parameters, remedial action requirements, or to complete environmental monitoring of some type. Data generated from these activities are used as the basis for decisionmaking.

5.1.1 Project Scoping

Before making decisions on data management requirements, a complete understanding of the project is required. Completing a scoping exercise based on client requirements and available information is the first step in planning for development of data management requirements. The following activities are included in the project scoping exercise:

- **Project Definition** - The effort to define projects is highly variable and completely dependent on the complexity of the project. For example, the project may be defined specifically in the client statement of work (e.g., sample wells 1, 2, and 3 and analyze water for volatile organics) or may be iterative where a specific condition may require investigation with further refinement of the project scope based on the results and findings (e.g., delineate nature and extent of contamination). Some projects may also be defined by first determining what questions need to be answered to meet the project objective. Therefore, project scoping can be conducted in multiple phases. First, the project scope is initially determined based on limited information and data (such as the information provided in the client statement of work). Next, after the review of more detailed and specific information, the project may be defined more accurately. Some projects may go through a systematic planning process such as implementing the data quality objective (DQO) steps where contractor, client, and regulators are involved. Project definition serves as the method of focusing and developing a conceptual model of the project so that appropriate management tools can be identified. For example, for a project where characterizing the nature and extent of contamination is the objective, the conceptual site model will include determining the environmental setting, the area of contamination, the contaminants of concern, fate and transport of contaminants of concern, and potential human health and ecological risks associated with contaminants of concern.

- **Identify Historical Information** - Information may exist from previous investigations and similar projects within the project boundaries. This information can prove to be valuable in providing insight into operational processes, contaminants of concern, and environmental compliance issues as well as geographical information.

- **Project Scoping Meeting** - A project scoping meeting must be held to finalize the project objectives, project decisions, and project tasks necessary to meet the project objectives. The scoping meeting may include the project team members only or may also include clients, regulators, and other technical team members such as project engineers/geologists and risk assessors.

- **Implement DQOs** - During the scoping meeting, DQOs shall be discussed and resolved. The following seven step DQO process shall be implemented:

  1. State the problem
  2. Identify the goal of the study
  3. Identify information inputs
  4. Define the boundaries of the study
  5. Develop the analytic approach
  6. Specify performance or acceptance criteria
  7. Develop the plan for obtaining data

- **Project Data Requirements** - During the scoping meeting, project data collection needs shall be clearly identified in terms of data use, quantity, and quality. Additionally, decision criteria, acceptable levels of uncertainty, and acceptable levels of false positive and false negative decisions need to be established in accordance with applicable data quality objective guidance.

5.1.2 Acquiring Existing Data

Environmental data collected during previous investigations and studies can prove to be valuable with respect to descriptive information and contaminants. Historical information may contain details in areas such as environmental compliance, geographical data, and characterization investigations. Existing data shall undergo the same review and evaluation as any recently collected information. This review assists in ensuring the quality of data collected during the initial stages of the project. While a quality review of this data is advisable, obtaining the necessary quality control data is not always possible. Included in the process of acquiring existing data are the following activities:

- **Locate the Existing Data** - The project manager will define the criteria by which existing data will be considered relevant (e.g., time period). Based on these criteria and additional information potentially provided by the client, a file search will be completed. These data can include physical, chemical, and geographic information.

- **Document Existing Data** - Once existing data have been located and acquired, documentation of these data must be completed. These data will be transferred into the project data management files.

- **Evaluate Existing Data** - Data users will evaluate the existing data for relevance to the current project objectives and data requirements. An essential part of this step is to determine the quality and suitability of the existing data to the current project objectives and requirements. Existing data may have been collected for very different intended uses. After evaluation, the project team will determine which existing data are useful and applicable to the current project. Documenting and inventorying the evaluation and data selected for inclusion to the project files must then be completed.

- **Process Existing Data** - The data manager will incorporate the appropriate existing data into the project database. Processing the data includes converting information into common systems to be used for the project (e.g., common coordinate systems). All data processing steps completed during conversion and incorporation must be documented.

5.1.3 Project Data Collection Planning

Before starting this step, the project goals and data requirements must be defined to allow for the development of more detailed project plans. Included in the process of planning project data collection are the following activities:

- **Data Requirements** - Project data requirements need to have been developed during the previous project scoping activities. Types of data that will be required include site operations with respect to:

  - Hazardous substances
  - Disposal practices
  - Quantities of hazardous substances
  - Potential migration of contaminants
  - Site conditions
  - Historical and aerial photographs and base map data
  - GIS coverage of soils, geology, hydrogeology, and delineated contaminated plumes

- **Develop Project Work Plans** - All projects require that guidance documents be developed to describe in detail how the project objectives will be met. These guidance documents will range in complexity dependent on the project type, project complexity, and the project regulatory requirements. The guidance document must be developed using the level of detail required to enable any entity to implement it. Examples of projects requiring guidance documents include:

  - Remedial investigation/feasibility studies
  - Remedial design/remedial action
  - Engineering evaluation/cost analysis

  Additionally, supporting plans and procedures may need to be developed to supplement the work plan. Examples of supplemental plans are:

  - Sampling and analysis plans
  - Quality assurance plans
  - Health and safety plans
  - Waste management plans

- **Develop the Laboratory Statement of Work** - The laboratory coordinator will prepare the laboratory statement of work specific to the project requirements determined in the project work plans. The laboratory statement of work must detail:

  - The number of samples to be sent for analysis
  - The analytical methods
  - Reporting limits
  - Laboratory quality assurance/quality control requirements
  - Data deliverable requirements

  The statement of work must define the electronic data deliverable format and requirements and request an example from the laboratory to confirm requirements will be met. Additionally, the laboratory statement of work must define the data deliverable requirements necessary to ensure that validation and evaluation may be completed.

- **Develop Data Validation and Evaluation Criteria** - The data validation coordinator is responsible for developing the data validation and evaluation process. The data validation and evaluation process will document the approach to verify that project DQOs are achieved. The range of effort required to meet the project validation and evaluation needs may range from none to very exhaustive, dependent on the client and project objectives. Validation and evaluation criteria may be modeled after national guidelines (e.g., National Functional Guidelines), client requirements (e.g., specific client work instructions or procedures), or a combination of both. Variables that are usually considered include:

- Sample preservation and holding times
- Calibration of instruments
- Blanks
- Laboratory quality control samples
- Field quality control analysis

The data validation and evaluation process will be included as a section in the project work plan or equivalent. If data validation and evaluation are completed by a subcontractor, the statement of work (detailing the project required process) will be developed.

5.2 Data Collection

The following data collection activities identify the data management team support and project team interactions that will ensure efficient field data and field sample collection, event documentation, data processing, and reporting.

5.2.1 Field Activity Preparation

After completing the work plan and detailed project plans, preparing for field activities is the next step. Preparing for field activities ensures that data and sampling processes for the project are complete and appropriate. Field preparation activities may include obtaining permits, surveying and marking sample locations, installing wells, and testing any required equipment. Data management team preparation activities include ensuring all data users have been trained and have access to the data management system, laboratory data deliverables can be transferred into the project database (laboratory test electronic data deliverables have been received and checked), project field forms have been created, an the records management requirements identified in the data management plan are established. Additional field preparation activities are detailed below.

- **Data Management Plan and Data File Management** - The data manager will ensure that the data management plan is implemented. Implementation of the plan must begin before collecting field data to ensure that the system developed is appropriate and functional. The data manager will also ensure that the data file management system is established before collecting field samples or measurements.

- **Site Survey** - The field team leader inspects the project site area for placement of sampling locations and equipment. These locations shall be documented on site maps and stored in the project files (hardcopy, GIS etc.). These identified locations shall be physically marked at the site with flagging, paints, stakes, etc.

- **Identification of Sampling Locations** - The sampling stations identified are differentiated by assigning a unique identifier to each location. Historical location identifiers must be confirmed and consistently used throughout the project. Geographic coordinates must then be obtained for each sampling location. The method of determining the geographic location shall be selected based on project accuracy requirements. Information used to select and document accuracy must be maintained. Examples of this information include the type of equipment, processing software, and accuracy reports.

- **Installation of Sampling Locations** - Sampling location installation will include the placement of:
  - Monitoring wells
  - Boreholes
  - Direct push locations
  - Cone penetrometer locations

  Record and maintain the following information:
  - Drilling and monitoring well construction information (e.g., borelogs, construction logs)
  - Development logs
  - Purging logs
  - Associated measurements (e.g., air monitoring, water quality monitoring)

- **Instrumentation and Equipment** - After placement of the sampling locations, any required instrumentation and equipment must be installed. An inventory of the instrumentation and equipment must be maintained. Included in the inventory will be:

  - The type and manufacturer of the instrument and equipment
  - Calibration requirements
  - Identification numbers
  - Type of data the instrument will collect

- **Project Database Update** - All information and data collected during the preparation activities shall be captured in the project database. After these preparatory steps have been completed, the collection of environmental data will begin. The project data manager shall be kept current on sampling and data collection schedules and activities.

5.2.2 Field Data Collection

Depending on the type of project, field data may consist of several different types. Field data may consist of observations, checklists, photographs, or preliminary field screening analytical data. Any time field data collection activities are conducted, they must be planned and scheduled. Data entry items such as checklists, field logbooks, and field data forms must be generated during the planning stage to ensure that the required data are captured. Information and data collected during the field data collection activities must enable the project team members to recreate or reconstruct the events that occurred during the activity. Due to project data needs ranging from simple to complex, not all steps provided below will apply to all projects.

- **Schedule** - The project manager is responsible for scheduling the field activity. Each field activity event will be defined by the site requirements and the data requiring collection. The appropriate work plans will be referenced to specify the data that will be collected. After completing the schedule, the field team and data manager are informed of the requirements by holding a field planning meeting.

- **Mobilization** - Mobilizing for a field activity includes generating any specific field forms or checklists, ordering, receiving and inspecting required field equipment, and conducting required project-specific training.

- **Field Data Forms** - Field data forms that will contain predefined information about the field event (e.g., location identifiers, site name, and quality control samples) shall be preprinted to ensure consistency and increase efficiency in the field. Some projects may have automated field data collection systems that would replace the need for field forms (e.g., data loggers). These data loggers will be prepared and tested at this time.

- **Field Instruments** - Many instruments used for collecting field measurements require calibration. Calibration of these instruments provides for accurate field measurements. Information that must be collected during the calibration of field equipment includes the type of instrument, instrument serial number or property number, time and date of calibration, instrument reading before and after calibration, and the calibration medium used. Calibrations of field equipment shall always be completed in accordance with the manufacturer's recommendations. For field equipment that only requires a calibration check, the vendor's date of calibration shall be recorded.

- **Field Data** - Field data are always collected at the same time as analytical samples. Examples of field data are:
  - Photographs
  - Water quality parameters
  - Checklists
  - Surveys
  - Time and date of sample collection
  - Weather conditions

- **Quality Assurance Review** - The project manager is responsible for ensuring that quality assurance reviews are completed. A quality assurance review of the field data collected will be completed. The field data (e.g., logbooks, field forms) review ensures that the data are recorded correctly and the activities are completed in compliance with the planning documents. The quality assurance review will determine if discrepancies between the planned events and actual events occurred.

- **Compilation of Field Data** - The field team leader is responsible for ensuring that the field data are compiled and submitted to the data manager. Compiling the field data will include copying the field forms, downloading data loggers, and verifying that the field data were recorded as required.

5.2.3 Field Data Processing

Processing field data provides the mechanism for making the data available to the data users. The project manager is responsible for completing this process. Field data will include logbook copies, field forms, checklists, and data logger data. Since project data collection will vary significantly from one project to the next, not every project will require the completion of the following steps. An important part of preparing the data management plan is defining this process specific to the project requirements.

- **Project Files** - The field data collected during the field activity and any changes or deviations implemented must be documented and placed into the project files.

- **Field Data** - The following steps only apply to a project where an electronic database is required. Hardcopy field data will be entered into the electronic database. The data entry will be reviewed for accuracy by an independent person to verify correctness. Electronic field data (e.g., from data loggers) will be processed by programs that are designed for use with the specific piece of equipment that logged the data.

- **Error Resolution** - Any errors identified during field data processing or on review of field documentation must be resolved. Resolution is accomplished through discussions with project personnel.

- **Updates** - Upon completion of field data processing, the project database and project files must be updated. The data manager then makes the data available to project personnel for use.

5.2.4 Field Sample Collection

Field sample collection includes all activities implemented to gather samples from a particular site. Field sampling activities are planned and scheduled. Before implementation, the required field data forms, field logbooks, etc. are prepared. Recorded information is intended to provide data and observations to enable the reconstruction of the field sampling activities. The following process steps can be implemented as required:

- **Schedule** - The project manager will prepare a schedule of sampling events. The schedule shall include the types and number of samples to be collected at each location.

- **Generation of Sampling Labels and Forms** - Each sample collected during the scheduled sampling event will receive a sample label and sample collection form. Information to be captured on the sample container labels includes the sample location, container type, preservative, and analysis. Field forms for each can also be generated. Field forms may be preprinted and include lines for documenting conditions under which the sample was collected (e.g., moisture content, depth, water quality parameters).

- **Notification of Analytical Laboratories** - The analytical laboratories need to be notified of the sampling activity schedule. The laboratory needs to be informed of the anticipated arrival of sample shipments including the numbers of samples and the types of analyses that will be requested.

- **Acquisition of Equipment and Supplies** - All equipment required to complete the field sampling activity must be ordered, received, and documented. Notation of all equipment identification numbers and serial numbers must be made. An equipment checklist may be used to document this step. All supplies needed to accomplish the scheduled sampling activities, including sample containers and shipping materials need to be assembled.

- **Sample Collection** - Samples will be collected in accordance with required sampling procedures. Information regarding sampling activities, site conditions, and deviations from the planning documents will be recorded in the field logbook or field data forms.

- **Sample Processing -** Samples collected in the field may need additional preparation before shipping to the laboratory. Two examples of additional processing that may be required are compositing of samples and filtering of an aliquot of the sample.

- **Updates -** The project database and project files need to be updated with the information collected during the field activities. A part of this process includes the verification that field data entered into the database are correct. Verification consists of comparing field forms and field logbooks to the information entered.

5.2.5 Submitting Samples for Analysis

Submitting samples to a laboratory for analysis includes preparation, packing, documenting, shipping, and verification of sample receipt. The process for submitting samples to a laboratory for analysis is detailed below.

- **Preparation for Shipment -** Preparing to ship samples includes the final sample processing such as splitting, compositing, or filtering. All sample containers shipped to a laboratory must have labels identifying, at a minimum, the sample number or identifier, analyses to be completed, and sample collection date and time. Sampling shipments shall be completed in accordance with CDM Federal SOP 2-1, *Packaging and Shipping of Environmental Samples*.

- **Chain-of-Custody Documentation -** All samples collected need to be documented and accompanied by a chain-of-custody form. The chain-of-custody must identify, at a minimum, the following:

  - Sample identification number
  - Matrix
  - Collection date and time
  - Sample type
  - Preservative
  - Analyses
  - Signature blocks for documenting sample transfers

  Sample chain-of-custody must be completed in accordance with CDM Federal SOP 1-2, *Sample Custody*.

- **Shipping Samples -** Samples will be shipped in accordance with CDM Federal SOP 2-1, *Packaging and Shipping of Environmental Samples*. Each sample shipped shall be checked against the chain-of-custody as it is packed for shipment.

- **Laboratory Receipt of Samples -** The laboratory will confirm that custody seals are still intact, the number of samples received matches the chain-of-custody, and the analyses match the sample labels and chain-of-custody. Additionally, the laboratory will note the condition of the samples when they are received against any noted requirements (e.g., 4° Celsius) on the chain-of-custody. The chain-of-custody will be signed and dated as received by the laboratory. A copy of the chain-of-custody shall be faxed back to the shipper for confirmation of sample receipt.

- **Confirmation of Sample Receipt -** The laboratory coordinator is responsible for confirming that the information provided by the laboratory is accurate. Confirmation is required for the following items:

  - What samples were received
  - Condition of samples upon receipt
  - Presence of signature on laboratory chain-of-custody form
  - Sample identification numbers
  - Types of analyses performed

  The laboratory coordinator is responsible for resolution and reconciliation of any conflicting information.

- **Sample Shipping Documentation -** Sample shipment files will include information with respect to the completion of the shipping process. This documentation will include:

  - Signed copy of the chain-of-custody
  - Shipping company airbill if applicable
  - Laboratory sample receipt or login form
  - Field forms associated with samples included in the shipment

- **Laboratory Analysis -** The laboratory will analyze samples according to the laboratory statement of work and the requested analyses identified on the chain-of-custody.

5.2.6 Sample Data Processing

Sample data processing includes receiving and processing the laboratory data package and making the data available for review. Activities associated with this process are data package receipt, evaluation of the data package, and updating the project database with the data package information. The process for these activities is detailed below.

- **Receiving the Data Package -** The laboratory shall send the data package to the project laboratory coordinator. At a minimum, the data package will consist of a hardcopy of the analytical results. The laboratory coordinator will note which samples the data package represents and review the data package for completeness and legibility. Any problems identified during this review must be communicated to the laboratory and corrected. If an electronic data deliverable is a part of the data package, it may be either sent directly to the data management team or retained by the laboratory coordinator and distributed after review. If an electronic data deliverable is not provided as a component of the data package and the data needs to be entered into the database, the laboratory coordinator will provide a copy of the data package to the data management team as required for data entry.

- **Evaluation of the Data Package -** Upon receipt of electronic data deliverables, the CD-ROM or other media will be scanned for possible viruses before loading the information onto a computer. If a virus is detected, the laboratory will be notified immediately and another electronic deliverable requested. Electronic data deliverables shall be compared to the hardcopy version of the data package to ensure consistency and accuracy. In cases where no electronic copy exists, and the entry of the hardcopy data package into an electronic database is a project requirement, verification of the accuracy of the entered data is required subsequent to completion of data entry. All errors and problems identified during the evaluation must be documented and resolved during the evaluation. Any changes made to the hardcopy data package and the electronic data package must be documented.

- **Update the Project Database -** The project database will be updated with the sample results and associated laboratory data qualifiers. Some projects may also require additional quality control information in the database. Examples of the type of information that may be required include:

  - Results from the matrix spike/matrix spike duplicates
  - Percent recoveries
  - Laboratory control samples
  - Blanks

  Documentation of problem resolution and changes made to the data package must be maintained.

5.3 Review and Data Use

The data review process determines whether a set of environmental data meets the requirements established during the project scoping. The process involves the data management team, the laboratory coordinator, and the data users. Before completing the data review, the data validation and evaluation process must be completed to ensure data meet analytical guidelines since qualifiers affect the usability of the data..

5.3.1 Data Validation and Evaluation

Validation and evaluation of environmental data is performed to evaluate the usability of the data for the intended application. The process is equally applicable to field data as well as analytical laboratory data. Data of questionable quality or representativeness are qualified to inform the data user of the limitations associated with the data use. The process to complete a data validation and evaluation is presented below.

- **Data Deliverables** - Data are received in either hardcopy or electronic format by the data validation coordinator. These data deliverables are evaluated against the requirements specified in the analytical laboratory statement of work or the client requirements. Upon completion of the evaluation of the data deliverables with respect to the contract requirements (laboratory subcontract or client contract), the data deliverables are forwarded to the validation and evaluation personnel. If the data validation and evaluation is not required for the data deliverable, it is forwarded to the data manager for uploading into the project database.

- **Validation and Evaluation of Data** - Data deliverables are validated and evaluated according to the procedures and requirements established during the project planning and data management plan development. Following validation and evaluation, the data are forwarded to the data management team for subsequent update of the project database.

- **Data Validation and Evaluation Report** - The data validator and evaluator will prepare a report documenting the process used to validate and evaluate the data, the usability of the data, and the qualification of the data, if applicable.

5.3.2 Data Review

Review of the data encompasses all data and supporting documentation, historical and recent, collected by the project activities as defined during the project scoping. Evaluation of the data will include the following process.

- **Evaluate Data for Outliers** - The data evaluation will first review the data to detect possible outliers. If extreme values are observed, a review of the potential for sampling and analysis problems must be completed to determine the accuracy of the data point. This review may include the evaluation of historical data ranges for the particular analyte at a particular location, or comparing similar analytical method results for samples processed differently (e.g., filtered vs. unfiltered). Based on the results of this evaluation, a determination about the use of the outlier result can be made.

- **Evaluate Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC)** - Precision, accuracy, representativeness, completeness, and comparability make up the PARCC parameters.

Precision is the degree of agreement between independent measurements and is determined by the evaluation of laboratory control sample and laboratory control sample duplicate pairs, the matrix spike/matrix spike duplicate pair or an environmental sample and environmental duplicate pair analyses.

Accuracy is the closeness of agreement between an observed value and an accepted value. Accuracy is determined by comparing percent recovery of spiked samples such as laboratory control samples and matrix spike samples.

Representativeness expresses the degree to which the data accurately reflect the analyte or parameter for the environmental media examined at the site. Representativeness is a qualitative term and is evaluated based on use of proper sample design, sample collection methods, use of standard analysis methods, etc.

Completeness is the measure of the amount of valid data received from the laboratory or field measurements. Completeness is determined by dividing the number of valid results by the number of possible results.

Comparability is the confidence with which one data set may be compared to another data set produced by different laboratories or field instruments. Comparability is a qualitative term and can be evaluated by reviewing sampling methods, sampling devices, and standard control limits. Understanding the PARCC parameters provides a level of confidence in the data reported for decisionmaking purposes.

- **Evaluate Data Quality** - An integral component of the data review process is the comparison of results against the project-specific data quality requirements established during project planning. Results of the data quality evaluation will determine if the data meet or exceed the data quality requirements necessary for decisionmaking. A final usability determination is made by the data reviewers. If required, data qualifiers are placed on the data to indicate usability.

- **Update Database** - After the data review is complete, the project database must be updated with the qualifiers assigned. Updating of the database also includes noting the qualifiers on the hardcopy of the data package.

5.3.3 Data Analysis and Use

Data analysis and use consists of the activities necessary to process the data and transform the entire data set into customized data sets for the generation of deliverables for decisionmaking and reporting. Data users may use only portions of data (e.g., geological or chemical) or summarize the data to generate tables, graphs, text, maps, or other deliverables necessary to describe the results obtained and the conclusions drawn. The analysis process is very often iterative. Results and conclusions from one analysis will often lead to other analyses. The process for data analysis and use is presented below.

- **Data Selection** - Data analysis will usually focus on a particular subset of the data collected. Data selection involves defining these subsets, querying the data, consolidating these data from the project database, and transferring the data to the appropriate tool for analysis (drafting, GIS, statistical program, etc.). Standardization may also need to occur at this point in the process (e.g., units, analytes, spatial).

- **Report and Analyze Data** - Data analysis involves summarizing the data to ensure that the technical requirements of the project are met. Examples of data analysis include statistical, risk assessment, and modeling. Results of the analysis are then used to report information in the form of tables, graphs, maps, text, and three-dimensional visualizations.

- **Documentation** - The information necessary to recreate a data analysis must be documented and kept. This includes the query criteria used to acquire the data subset, the database that provided the data for analysis, the procedure completed to perform the analysis, and the date the analysis is performed.

6.0 Software and Computer System

This section defines the documentation, quality assurance, and configuration control requirements for software and databases used on environmental projects. Section 6.1 applies to all projects using an electronic database and provides requirements for project-specific databases and software. Section 6.2 applies to all projects using an electronic database and defines requirements for the day-to-day operation of the data management system. The project data manager is responsible for implementation and providing guidance to meet the project objectives.

6.1 Project-Specific Database and Software Requirements

The need for a project-specific database and software will vary depending on the requirements of the project. A project may use an existing data management system and therefore not have project-specific software or databases, while other projects may develop project-specific databases and spreadsheets or software programs to analyze the project data. This section presents the minimum documentation, quality assurance, and configuration control requirements for project-specific databases and software developed during the course of a project.

- **Database Documentation** - Project databases will include spreadsheets and databases defined by the project data management team. The database documentation will identify the commercial database product, the database name, structure, and location using an entity relationship diagram (ERD) and data dictionary. The backup and recovery plans and processes for the database will also be documented. The minimum database documentation will consist of the name of the software used, names of the project databases created, database structure definitions (including names and field descriptions), any table relationships, and the storage location.

- **Software Documentation** - Software documentation will include the software program name, description, special requirements, revision, completion date, and evidence of technical and quality review. Documentation of deliverables created must also include the necessary information required to describe exactly how the data deliverable was produced. Software documentation may be maintained in hardcopy or included as a comment block embedded within the project software program. The minimum software documentation will consist of the name of the commercial software, name and version of any software written by the project personnel, author, date, revision, system requirements, and storage location.

- **Software Quality Assurance** - The project will define the quality assurance requirements for project-specific software. At a minimum, the functionality and analytical results of software programs will be reviewed to ensure that they meet requirements and objectives. The reviewer of the software will be someone other than the person who wrote the program. The project-specific software quality assurance requirements will be defined in the project data management plan.

- **Software Configuration Control** - Project-specific software will be protected from unauthorized modification or deletion. This can be accomplished by administrative controls or file security options. Changes to project software will be documented and maintained in the project files. The minimum project software configuration control documentation will include the commercial software used, the program names, revisions including the date, and the storage location.

6.2 System Administration

This section addresses the day-to-day operations of the data management system, including backups, access, security, data entry, and database control. All projects using an electronic database will adhere to the requirements in this section. The data manager is responsible for implementation of system security.

- **System Backup** - Project data will be protected from loss through a preventive backup and recovery process. Database backups will be performed on a periodic basis at a frequency to be defined for each project in the data management plan. The frequency will be selected to minimize the extent of consequences of data loss and time required to recover the data. Recovery procedures will be developed and documented. The detailed description of the backup and recovery procedures will be presented in the data management plan.

- **System Access** - Access to the computer system will be made available only to authorized personnel with an assigned role that specifies their access rights. Before gaining access, personnel may login by providing a login name and password.

- **Database Access** - Projects will protect data from unauthorized access by implementing administrative controls. Access will be managed based on the specific data user role. The mechanism for implementing control will be documented in the project data management plan.

- **Data Security** - Security considerations must establish a balance between making the data inaccessible to unauthorized individuals while still making it accessible to those who have access and maintaining the integrity of the data. Security processes apply to field data, electronic data, the database, and distribution of data outside of CDM. Original copies of all field records (e.g., chain-of-custody forms, sample collection sheets, and shipping airbills) will be placed in the permanent project file. All electronic files will be maintained in an electronic file management system and administered accordingly. Security of data distributed outside of CDM will be maintained by providing read only access to the data and/or including time, date, and version on the data files within the file naming convention.

- **Data Entry** - Data entry and transcription activities will be reviewed and checked to ensure that data integrity is maintained. Review and checking must occur for all data when moving or copying data from one media to another. For example, if a field technician collects data from a water quality instrument and records it in a logbook, enters the data from the logbook into an electronic format, and then transfers the data into a deliverable, verification of accuracy would be completed during or immediately after the transcription. The mechanism for data entry and transcription must be documented in the project data management plan.

- **Database Control** - Each project must establish database control requirements for the contents of the project database. The requirements must ensure traceability of field and laboratory data from its original reported values through changes to current values stored in the database. The control requirements will define the approval process required for making changes to the database and the documentation required for each database change. The minimum information maintained for each database change will include:

  - Description of the change
  - Reason the change was made
  - Name of the individual making the change
  - Date the change was made

7.0 References

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__________. 2004. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA540-R-04-004. October

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TSOP 4-9

AQUIFER PERFORMANCE TEST

Aquifer Performance Tests	SOP 4-9 Revision: 0 Date: May 6, 2005

Prepared:	Aaron Frantz	**Technical Review:**	Michael Smith
QA Review:	Doug Updike	**Approved:**	5/05/05 Signature/Date
Issued:	5/5/05 Signature/Date		

1.0 Objective

The purpose of this standard operating procedure (SOP) is to define requirements for conducting a constant rate aquifer performance test (APT).

2.0 Background

Many different methods and techniques are performed to determine hydraulic properties of an aquifer (American Society for Testing and Materials 2004). The methods and techniques in this procedure are for a standard constant-rate withdrawal test to be conducted at a nonflowing well. APTs are commonly performed in wells that will ultimately be used to withdraw groundwater for an extended period of time. These wells are typically 6 inches or more in diameter and are used for purposes such as drinking water (a supply well), contaminated groundwater removal (a recovery well), and industrial processes (production well). However, tests can be run in other well types and sizes (e.g., a monitoring well that is 4 inches in diameter). The information collected during an APT is used for defining the hydraulic characteristics of the aquifer. Data collected during an APT can also be used to assess pump selection and water delivery piping.

2.1 Definitions

Pumping well - The well from which water is withdrawn during an APT.

Observation well - A well that is used to monitor the groundwater level at some distance from the pumping well during an APT.

Stilling pipe - A small diameter (about 1 inch) pipe that is installed in the pumping well from the top of the pump to the surface; the transducer is placed in the pipe.

2.2 Discussion

In general, APTs consist of withdrawing water from a pumping well for a specified time period and monitoring the water level in the pumping well and observation wells. The recorded time-drawdown data are then reduced and analyzed to:

- Determine the specific capacity and safe yield of the well
- Calculate the properties (transmissivity [T] and storativity [S]) of the aquifer (T may be estimated from pumping well and observation well data; S may be estimated from observation well data)
- Characterize the hydrogeologic framework at and near the investigation area

These three items, or one of the items at a minimum, are typically evaluated with APT data. However, other ancillary but useful information (e.g., water quality changes under stressed conditions) may also be obtained from the APT data. During the planning stages of the APT, the objectives of the test shall be specified so that the necessary data to reach the objectives are collected when the test is performed.

2.3 Associated SOPs

- CDM Federal (CDM) SOP 1-6, *Water Level Measurement*
- CDM SOP 1-10, *Field Measurement of Organic Vapors*
- CDM SOP 2-2, *Guide to Handling of Investigation-Derived Waste*
- CDM SOP 4-1, *Field Logbook Content and Control*
- CDM SOP 4-4, *Design and Installation of Monitoring Wells in Aquifers*
- CDM SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 Roles and Responsibilities

Site Manager - Translates client's requirements into technical direction of project. Sets technical criteria, reviews, and approves technical progress. Ensures that all participating personnel have proper training. ***Note***: Other titles such as project manager may be used.

Field Team Leader (FTL) - Supervises field operations. Ensures that all necessary equipment, including safety equipment, is available and functioning properly before project operations begin. Ensures that all necessary personnel are mobilized on time. Maintains daily log of activities each work day.

Field Geologist - Collects and maintains data. Coordinates and consults with site manager on decisions relative to unexpected encounters during testing and deviations from this SOP. Directs overall activities of testing procedures and support subcontractors.

4.0 Required Equipment

Water measuring and recording:

- Pressure transducers and data logger
- Personal computer for viewing and downloading data
- Water level measuring device
- Stopwatch
- Field logbook
- Decontamination equipment and supplies
- Data on construction of the pumping well (depth to screen and screen length)

Water pumping, treating, storing, and discharging:

- Pump (sufficient capacity to withdraw at the required rate) with electric wiring
- Discharge hosing/piping
- Electrical source (e.g., generator)
- Flowmeter with totalizer
- Sampling valve
- Water treatment unit (if required)
- Water storage container (if required)
- Ancillary equipment and supplies to install and/or operate the main equipment

A field service subcontractor will typically be responsible for providing and operating the equipment for pumping, treating, storing, and discharging water. However, in some cases, it may be appropriate for the pumping, treating, storing, and/or discharging equipment to be provided and operated by those that also provide and operate the water measuring and recording equipment. The project requirements and structure will need to be evaluated to determine the most suitable arrangement for providing and operating the necessary equipment.

5.0 Procedures

An APT has five main components:

- Preparation
- Continuous background monitoring
- Step-drawdown test
- Long-term constant rate test
- Discharge water management

Sometimes only the long-term constant rate test is performed and the background monitoring and the step-drawdown tests are omitted. Therefore, the long-term test is sometimes referred to as an APT.

A form that provides typical general information that should be recorded for each test is provided at the end of this SOP.

5.1 Preparation

Adequate attention to the planning and design of the APT is a significant phase of the procedure and will ensure that useful results are produced (U. S. Geological Survey 1976, U. S. Environmental Protection Agency 1993). A planning meeting shall be held to identify the objectives of the APT and then the scope of the APT shall be developed. After the objectives are identified and the scope is developed, an APT plan shall be prepared that describes the procedures to be followed. The plan shall identify and describe the details to be followed for each component of the APT.

5.2 Continuous Background Monitoring

Water levels shall be collected continuously prior to performing the long-term test. Adjacent surface water bodies should also be monitored. The water levels shall be used to reduce and analyze the data collected during the long-term test. The background data is also useful in characterizing the hydrogeologic framework.

Transducers/loggers shall be installed in the pumping well and the observation wells. Each transducer/logger shall be checked and set following the manufacturer's manual, including setting the internal clock to a common external standard. Each transducer shall be installed to a depth that does not exceed the working capacity of the transducer and where the water level will not drop below the transducer during ambient water level changes. After the selected depth is reached with the transducer:

- Securely attach the cable to the well head and mark a reference point with electrical tape to allow verification that the transducer position does not change during the test
- Read the depth of water using the transducer (note that the transducer may need to equilibrate with the water temperature following the manufacturer's specifications and recover from displacement of water caused by submersion of the transducer)
- Collect a manual water level measurement from the well's measuring point
- Begin recording water levels on a linearly rate of 1 reading per 30 minutes

Transducers shall be programmed so that water level recording begins at the same time at each well. Having water levels recorded at the same time for each well simplifies the data reduction and evaluation activity contrasted to having water levels recorded at different times for different wells.

Background water levels shall be recorded for 7 days. During the monitoring period, the transducers/loggers should be occasionally checked (e.g., check the transducers on day two and day five) to verify that the equipment is working properly. Manual water level measurements should be taken and recorded during this check. Replace any transducer that is identified to be not operating correctly.

At the end of the monitoring period, stop the test recording and download the recorded data.

Barometric pressure (BP) and precipitation shall be recorded during the background monitoring period. These two elements are commonly considered the main natural factors to impact groundwater levels. If publicly available data can be obtained from a weather station located nearby (within approximately 5 miles of the project), the data from that station may be used. BP and precipitation data shall also be recorded during the long-term test.

5.3 Step Drawdown Test

The step drawdown test (or simply, step test) is required to determine the constant pumping rate that will be used for the subsequent long-term test and to assess well efficiency. Step test data may also be used to evaluate the hydrogeologic characteristics. The step test is performed at the pumping well. In summary, the step drawdown test consists of pumping water from the well at short incrementally increased rates (steps) so that a withdrawal rate can be determined for the long-term test.

A pump capable of yielding 1.5 times the estimated yield of the pumping well shall be installed to the specified depth. A vertical check valve will be placed in the discharge line immediately above the pump or intake to prohibit water from draining into the well when the pumping ceases. A 1-inch diameter polyvinyl chloride line will be placed in the well with the bottom end open to a depth within 1 foot from the top of the pump. Several ¼-inch diameter holes should be drilled in the bottom 5 feet of this stilling pipe. The water level transducer will be installed in the pipe. After the pumping equipment and transducer are installed, the following steps will be followed:

- Connect a flow meter/totalizer and sample tap with valve to the discharge line from the pump; direct the discharge line to the system to handle the water. Care must be taken to provide sufficient straight sections of pipe above and below the flow meter to obtain accurate measurements. Recent calibration certificates should be obtained for the flow meter.
- Record the volumetric reading on the totalizer (***Note***: Prior to pumping and increasing pumping rate and after ending pumping, the volumetric reading should be recorded).
- Measure and record the static water level in the pumping well.
- Begin logging with the transducer and then start pumping water from the pumping well at a relatively low (approximately ½ of the estimated yield) but steady rate (STEP 1); logging should be started approximately 2 to 5 seconds prior to starting pumping. Flow should be adjusted to maintain a constant rate, noting when changes are made.
- Record the time at which pumping is started, using a clock that is synchronized with the transducer clocks, and the flow rate; check operation of the transducer.
- Monitor the water level in the pumping well with the transducer and confirm periodically with manual measurements.
- After approximately 1½ hours, increase the pumping rate to approximately ¾ of the estimated yield, and continue to monitor the water level for approximately 2 hours (STEP 2).
- Record the time at which the pumping rate is increased and the new flow rate; check operation of the transducer.
- Approximately 2 hours after increasing the pumping rate for STEP 2, increase the pumping rate to approximately equal to the estimated yield, and continue to monitor the water level for approximately 2 hours (STEP 3).
- Record the time at which the pumping rate is increased and the new flow rate.
- Approximately 2 hours after increasing the pumping rate for STEP 3, increase the pumping rate to approximately 1.5 x the estimated yield, and continue to monitor the water level for approximately 2 hours (STEP 4).
- Record the time at which the pumping rate is increased and the new flow rate.
- Shut off the pump at the end of STEP 4 (maximum of 8 hours has elapsed since pumping started at the beginning of the test) and download data. The transducer should continue recording during the recovery period.

A step test is dynamic. During each step the operator will gain more information on how the well's water level responds to specified pumping rates. The estimated increases identified above for each step should only be used as a guide. Each successive increase should be based on the operator's general understanding of well hydraulics, observations made while installing and developing the well, and on the well's response during the previous step(s). The goal, in summary, is to achieve the well yield at STEP 3 and exceed the well yield at STEP 4.

During the test, water levels at the pumping well shall be recorded logarithmically following the recommended schedule in the following chart. Typical data loggers have default sample intervals except for the largest sample interval, which is set by the user (in the table below, the 10-minute sample interval is set by the user). The default sample intervals shall be equal to or similar to the table below.

Log Cycle	*Elapsed Time*	*Sample Interval*	*Points/Cycle*
1	0 to 20 seconds	0.2 second	101
2	20 to 60 seconds	1 second	40
3	1 to 10 minutes	10 seconds	54
4	10 to 100 minutes	2 minutes	45
5	100 to 1,000 minutes	10 minutes	90

The drawdown-time data shall be plotted semi-logarithmically. The drawdown (y-axis) shall be plotted on a linear scale and time (x-axis) shall be plotted on a logarithmic scale. The drawdown curves shall be extrapolated to the specified time of the proposed long-term test. The rate that results in the maximum drawdown without dropping the water level below the design pumping level within the time period of the long-term test shall be considered the flow rate to be used for the long-term test. The specific capacity versus pumping rate should also be plotted to determine if excessive well losses occur at the selected rate.

5.4 Long-Term Constant Rate Test

The long-term constant rate test will be performed at the pumping well. Water levels will be monitored in the pumping well and the observation wells. The same pumping equipment used for the step test will be used for the long-term test. BP and precipitation shall be recorded during the long-term test. If publicly available data can be obtained from a weather station located nearby (within approximately 5 miles of the project), the data from that station may be used. Adjacent surface water bodies should also be monitored if the surface water is potentially connected to the groundwater system.

The time interval for the long-term constant rate test shall be specific to the project. However, at a minimum, a confined aquifer should be pumped for 24 hours and an unconfined aquifer to be pumped for 72 hours (American Water Works Association 1997). The project objectives will need to be reviewed and aquifer test solution requirements considered so that the correct pumping period is selected. The following steps shall be followed to conduct the long-term test after the step test is completed.

- Install transducers in the pumping well and the observation wells (note that transducers can be installed in observation wells prior to the day the long-term test starts).
- Read the water level depths with the transducers and record the values; measure and record the static water levels with the electronic water level meter from the wells' measuring points.
- Record the volumetric reading on the totalizer.
- Begin logging water level data with the transducers and then start pumping at the predetermined rate (determined based on the step-drawdown test results).
- Periodically monitor discharge rate and transducers; maintain constant pumping rate.
- Stop pumping at the end of the specified time, record volumetric reading on the totalizer.
- Continue to record water level data with transducers until the water level in the pumping well has recovered so that sufficient data are collected to adequately analyze the recovery or a maximum of 24 hours has elapsed.

The water level data will be transferred to disk form so that it may be reduced, analyzed, and put into report format.

The water levels in the wells will be recorded logarithmically following the recommended schedule in the following chart:

Log Cycle	Elapsed Time	Sample Interval	Points/Cycle
1	0 to 20 seconds	0.2 second	101
2	20 to 60 seconds	1 second	40
3	1 to 10 minutes	10 seconds	54
4	10 to 100 minutes	2 minutes	45
5	>100 minutes	10 minutes	unspecified

When the pump is shut off and recovery begins, a new logarithmic series will be started for the transducer in the pumping well. The series shall be started 1 to 5 seconds prior to ending the pumping activity. The transducers in the observation wells will continue to monitor on the first logarithmic cycle series. If the aquifer is expected to recover quickly, the observation well transducers may also be restarted on a new series. Data will be recorded until the water level in the pumping well has returned so that sufficient data are collected to adequately analyze the recovery or until a maximum of 24 hours has elapsed. A manual water level measurement shall be collected from the wells, measuring points, and a reading should be taken with the transducers during recovery.

At the conclusion of the recovery test, the data logging shall be stopped at each well and the transducers shall be removed and the data downloaded.

5.5 Discharge Water Management

The water pumped from the well shall be discharged and managed following the plan specific to the project. Several methods may be used to handle the discharge water from an APT. The water may be discharged:

- Directly to the ground surface or a water body, if permitted by the regulatory agencies. Such discharge should be at a sufficient distance from the pumping and observation wells so that the test is not impacted if water infiltrates to the aquifer.
- To a holding tank, sampled and analyzed after the test, and then released to the ground surface or water body after analytical results prove that discharge requirements are met.
- To a unit designed and constructed to treat the water to meet discharge criteria; treated and then released to the ground surface or water body.

Also, a combination of the three options above may be used. Other discharge options may also be available and followed.

In summary, several different methods are typically available to handle discharge water. The governing agency shall be contacted so that required water handling practices are followed and discharge criteria are met.

6.0 Data Reduction and Analysis

The data sets from an APT are typically very robust. The data may be reduced and analyzed to:

- Determine the specific capacity and safe yield of the well
- Calculate the properties (T and S) of the aquifer
- Characterize the hydrogeologic framework at and near the investigation area

These three items, or one of the items at a minimum, are typically evaluated with APT data. Other pumping test data may also be available and evaluated.

APT data are recommended to be analyzed with computer software; however, data may also be analyzed manually. The CDM groundwater modeling tool kit contains Aquifer^{Win32}, which is a program that may be used to assist in analyzing test data. Other programs are also available. Software packages are useful since they can be used to manage a significant amount of data in short time periods and contain many different confined and unconfined test solutions. The trained user can use these benefits to generate detailed response curve graphs, precise hydraulic values, and insights into the hydrogeologic framework near the well. Regardless of the analytical method employed or whether the data is analyzed manually or by computer, the analyst should review the original technical paper or textbook summary of the method in order to understand the mechanics and assumptions underlying the method prior to attempting any analysis and verify the method is appropriate for the site conditions.

APT data analyses and hydraulic property calculations shall be performed by an experienced professional, documented in a calculation brief, and reviewed. Data analysis and parameter calculations are beyond the scope of this SOP and, therefore, are not discussed here.

7.0 Restrictions/Limitations

This procedure describes the standard steps used to conduct a constant rate APT. Since APTs are complex and project objectives and site requirements vary, not every step or possible method was incorporated into the procedure.

A planning meeting shall be held to identify the objectives of the APT, then the scope of the APT shall be developed. After the objectives are identified and the scope is developed, an APT plan shall be prepared that describes the project-specific procedures to be followed. The plan shall describe the details to be followed for each component of the APT. The objectives of the test shall be specified so that the necessary data to reach the objectives are collected when the test is performed.

8.0 References

American Society for Testing and Materials. 2004. Standard Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques. D 4043-96 (Reapproved 2004).

__________. 2002. Standard Test Method (Field Procedure) for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems. D 4050-96 (Reapproved 2002).

American Water Works Association. 1997. AWWA Standard for Water Wells (ANSI/AWWA A 100-97).

Environmental Simulations, Inc. 2000. Guide to Using Aquifer^{Win32}.

U. S. Environmental Protection Agency. 1993. Ground Water Issue Suggested Operating Procedures for Aquifer Pumping Tests (EPA/540/S-93/503). February.

U. S. Geological Survey. 1976. Techniques of Water-Resources Investigations of the United States Geological Survey (Chapter B1 Aquifer Test Design, Observation and Data Analysis).

Aquifer Test Data

Project Name:	Date:
Pumped Well ID:	Weather:
Observation Well ID:	Personnel:
Well locations (*provide sketch or attach map*): Include: Scale/dimensions, north arrow, and significant features (*e.g., surface water*)	
This sheet records data for (*well ID*):	
Measuring Point:	(*e.g., notch or inner casing*)
Static Water Level:	(*feet below measuring point [ft BMP]*)
Static Water Level Date:	Time:
Interval Open/Screened to Aquifer (*ft BMP*):	
Pump Setting Depth (*ft BMP*):	
Pump Model:	Serial No.:
Flow Meter Model:	Serial No.:
Logger/Transducer Model:	Serial No.:
Totalizer Reading before Pumping:	
Date/Time Pumping Started:	
Discharge Rate (*gpm*):	

Date	*Time*	*Manual Water Level Measure* (ft BMP)*	*Discharge (gpm)*	*Comments*

*Use more sheets if more rows are needed.

Date/Time pumping ended: ______________________________

Totalizer reading at end of pumping: ______________________________

(One sheet to be completed for each well)

TSOP 5-1

CONTROL OF MEASUREMENT AND TEST EQUIPMENT

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 5 - 1
Revision: 5
SOP Title: CONTROL OF MEASUREMENT AND TEST EQUIPMENT Date: March 26, 2003

QA Review: E-Signed by Jeniffer Oxford VERIFY authenticity with Approve

Approved and Issued: E-Signed by Jeanne Litwin VERIFY authenticity with Approve
Program Manager Signature/Date

Contract No.: RAC II Client: USEPA, Region II

Reason for and Clarification: Make SOP USEPA Region II – Specific

Clarification (attach additional sheets if necessary; state section and page numbers when applicable):

2.0 BACKGROUND

2.2 Discussion, add (to page 1 of 7):

As the RAC II contract does not use any company-owned or government furnished equipment, only procedures discussed for leased and rented measurement and test equipment apply.

Prepared: Dave Johnson

Technical Review: Steve Guthrie

QA Review: Jo Nell Mullins

Approved: E-Signed by Michael C. Malloy VERIFY authenticity with ApproveIt Michael C. Malloy

Signature/Date

Issued: E-Signed by P. Michael Schwan VERIFY authenticity with ApproveIt Michael Schwan

Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to establish the baseline requirements, procedures, and responsibilities inherent to the control and use of all measurement and test equipment (M&TE). Contractual obligations may require more specific or stringent requirements that must also be implemented.

2.0 Background

2.1 Definitions

Traceability - The ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

2.2 Associated Procedures

- CDM Federal Technical SOP 4-1, *Field Logbook Content and Control*
- CDM Quality Procedures (QPs) 2.1 and 2.3
- Manufacturer's operating and maintenance and calibration procedures

2.3 Discussion

M&TE may be government furnished (GF), rented or leased from an outside vendor, or purchased. It is essential that measurements and tests resulting from the use of this equipment be of the highest accountability and integrity. To facilitate that, the equipment shall be used in full understanding and compliance with the instructions and specifications included in the manufacturer's operations and maintenance and calibration procedures and in accordance with any other related project-specific requirements.

3.0 Responsibilities

All staff with responsibility for the direct control and/or use of M&TE are responsible for being knowledgeable of and understanding and implementing the requirements contained herein as well as any other related project-specific requirements.

The project manager (PM) or designee (equipment coordinator, quality assurance coordinator, field team leader, etc.) is responsible for initiating and tracking the requirements contained herein.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Requirements for M&TE

- Determine and implement M&TE related project-specific requirements
- The maintenance and calibration procedures must be followed when using M&TE
- Obtain the maintenance and calibration procedures if they are missing or incomplete
- Attach or include the maintenance and calibration procedures with the M&TE
- Prepare and record maintenance and calibration in an equipment log or a field log as appropriate (Figure 1)
- Maintain M&TE records
- Label M&TE requiring routine or scheduled calibration (when required)
- Perform maintenance and calibration using the appropriate procedure and calibration standards
- Identify and take action on nonconforming M&TE

5.0 Procedures

5.1 Determine if Other Related Project-Specific Requirements Apply

<u>For all M&TE:</u>
The PM or designee shall determine if M&TE related project-specific requirements apply. If M&TE related project-specific requirements apply, obtain a copy of them and review and implement as appropriate.

5.2 Obtain the Operating and Maintenance and Calibration Documents

<u>For GF M&TE that is to be procured</u>:
Requisitioner - Specify that the maintenance and calibration procedures be included.

<u>For GF M&TE that is acquired as a result of a property transfer</u>:
Receiver - Inspect the M&TE to determine whether maintenance and calibration procedures are included with the item. If missing or incomplete, order the appropriate documentation from the manufacturer.

<u>For M&TE that is to be rented or leased from an outside vendor</u>:
Requisitioner - Specify that the maintenance and calibration procedures, the latest calibration record, and the calibration standards certification be included. If this information is not delivered with the M&TE, ask the procurement division to request it from the vendor.

5.3 Prepare and Record Maintenance and Calibration Records

<u>For all M&TE</u>:
PM or Designee - Record all maintenance and calibration events in a field log unless other project-specific requirements apply.

<u>For GF M&TE only (does not apply to rented or leased M&TE):</u>
If an equipment log is a project specific requirement, perform the following:

Receiver - Notify the PM or designee for the overall property control of the equipment upon receipt of an item of M&TE.

PM or Designee and User:
- Prepare a sequentially page numbered equipment log for the item using the maintenance and calibration form (or equivalent) (Figure 1).
- Record all maintenance and calibration events in an equipment log.

5.4 Label M&TE Requiring Calibration

<u>For GF M&TE only (does not apply to rented or leased M&TE):</u>
If calibration labeling is a project specific requirement, perform the following:

PM or Designee:
- Read the maintenance and calibration procedures to determine the frequency of calibration required.
- If an M&TE item requires calibration before use, affix a label to the item stating "Calibrate Before Use."
- If an M&TE item requires calibration at other scheduled intervals, e.g., monthly, annually, etc., affix a label listing the date of the last calibration, the date the item is next due for a calibration, the initials of the person who performed the calibration, and a space for the initials of the person who shall perform the next calibration.

5.5 Operating, Maintaining or Calibrating an M&TE Item

<u>For all M&TE:</u>
PM or Designee and User - Operate, maintain, and calibrate M&TE in accordance with the maintenance and calibration procedures. Record maintenance and calibration actions in the equipment log or field log.

5.6 Shipment

<u>For GF M&TE</u>:
Shipper - Inspect the item to ensure that the maintenance and calibration procedures are attached to the shipping case, or included, and that a copy of the most recent equipment log entry page (if required) is included with the shipment. If the maintenance and calibration procedures and/or the current equipment log page (if required) is missing or incomplete, do not ship the item. Immediately contact the PM or designee and request a replacement.

For M&TE that is rented or leased from an outside vendor:
Shipper - Inspect the item to ensure that the maintenance and calibration procedures and latest calibration and standards certification records are included prior to shipment. If any documentation is missing or incomplete, do not ship the item. Immediately contact the procurement division and request that they obtain the documentation from the vendor.

5.7 Records Maintenance

For GF M&TE:
PM or Designee - Create a file upon the initial receipt of an item of M&TE or calibration standard. Organize the files by contract origin and by M&TE item and calibration standard. Store all files in a cabinet, file drawer, or other appropriate storage media at the pertinent warehouse or office location.

Receiver - Forward the original packing slip to the procurement division and a photocopy to the PM or designee.

PM or Designee and User:
- Maintain all original documents in the equipment file except for the packing slip and field log.
- File the photocopy of the packing slip in the M&TE file.
- Record all maintenance and calibration in an equipment log or field log (as appropriate). File the completed equipment logs in the M&TE records. Forward completed field logs to the PM for inclusion in the project files.

For M&TE rented or leased from an outside vendor:
Receiver - Forward the packing slip to the procurement division.

User:
- Forward the completed field log to the PM for inclusion in the project files.
- Retain the most current maintenance and calibration record and calibration standards certifications with the M&TE item and forward previous versions to the PM for inclusion in the project files.

5.8 Traceability of Calibration Standards

For all items of M&TE:
PM or Designee and User:
- When ordering calibration standards, request nationally recognized standards as specified or required. Request commercially available standards when not otherwise specified or required. Or, request standards in accordance with other related project-specific requirements.
- Require certifications for standards that clearly state the traceability.
- Require Material Safety Data Sheets to be provided with standards.
- Note standards that are perishable and consume or dispose of them on or before the expiration date.

5.9 M&TE That Fails Calibration

For any M&TE item that cannot be calibrated or adjusted to perform accurately:
PM or Designee
- Immediately discontinue use and segregate the item from other equipment. Notify the appropriate PM and take appropriate action in accordance with the CDM QP 2.3 for nonconforming items.
- Review the current and previous maintenance and calibration records to determine if the validity of current or previous measurement and test results could have been affected and notify the appropriate PM(s) of the results of the review.

6.0 Restrictions/Limitations

On an item-by-item basis, exemptions from the requirements of this SOP may be granted by the Headquarters health and safety manager and/or Headquarters quality assurance director. All exemptions shall be documented by the grantor and included in the equipment records as appropriate.

7.0 References

CDM Federal Programs Corporation. 2007. *Quality Assurance Manual.* Rev. 11.

CDM Federal Programs Corporation. 2005. *Government Property Manual.* Rev. 3.

Figure 1

CDM
A subsidiary of Camp Dresser & McKee Inc.

Maintenance and Calibration

Date: Time: (a.m./p.m.)
Employee Name: Equipment Description:
Contract/Project: Equipment ID No.:
Activity: Equipment Serial No.:

Maintenance

Maintenance Performed:

Comments:

Signature: Date:

Calibration/Field Check

Calibration Standard: Concentration of Standard:
Lot No. of Calibration Standard: Expiration Date of Calibration Standard:
Pre-Calibration Reading: Post-Calibration Reading:
Additional Readings: Additional Readings:
Additional Readings: Additional Readings:
Pre-Field Check Reading: Post-Field Check Reading:
Adjustment(s):

Calibration: ☐ Passed ☐ Failed
Comments:

Signature: Date:

Appendix C

APPENDIX C

FIELD FORMS

Anset Form
Daily Sign-In Sheet
Daily Status Report
Drilling Summary Sheet
Drum Tracking Log
Equipment Calibration Logs
Field Change Request Form
Low Flow Sampling Form
MultiRAE Calibration
Onsite Screening Tracking Log
Sample Tracking Log
Subcontractor Laboratory Sample Tracking Log

ANSETS Data Requirement

Date:		Sampling Start Date: Sampling End Date:	
Project Numbers			
Project Number:	Regional Account Number:	DAS Number:	Assoc. CLP Case No:
Site Name: Old Roosevelt Field Contaminated Groundwater Area site		City:	State:
CERCLIS ID:	Operable Unit:	Action:	Funding Lead:
Responsible EPA Project Individual:		Sampling Organization:	CDM

Analytical Services Information	
If field analytical services are used during this project write "field analysis" in the Laboratory Name Column. If fixed laboratory is used write the name of the laboratory in the Laboratory Name Column. Please specify in this box all field analytical techniques used.	COST:

Laboratory Name (include location if multiple lab locations)	No. Samples	Matrix	Analysis	Requested Turnaround (Days)

Completed by:	Organization:	Date:

DAILY SIGN-IN SHEET
Old Roosevelt Field Contaminated Groundwater Area Site

Date	Print Name	Signature	Affiliation	Time On-Site	Time Off-Site

Daily Field Activity Summary Report
Old Roosevelt Field Groundwater Contamination Site
Pre-Remedial Design Investigation
Nassau County, New York

DATE:

WEATHER:

PERSONNEL ONSITE

CDM Federal	Subcontractors	Others

FIELD EVENT: Pre-Remedial Design Investigation

FIELD WORK PERFORMED

MISCELLANEOUS

FTL SIGNATURE:____

Old Roosevelt Field Pre-Remedial Design Investigation
Daily Drilling Sign-off Sheet

Date: ____________

Item	Description	Unit	Estimated Total Quantity	Daily Quantity
1. GENERAL				
1a	Mobilization/Demobilization	lump sum	1	
1b	Steam Cleaning	hour	30	
1c	55-Gallon Drums (to include pallets)	drum	10	
1d	Standby Time	hour	10	
1e	Crew Per Diem	crew day	55	
1f	Clearing/Grading	hour	20	
1g	Security Fence Construction and Rental *(SVP-11 area: assume one 40' x 40' area for 1 month)*	lump sum	1	
1h	Asphalt Repair *(assume three 30' x 30' areas)*	cubic foot	2,700	
2. MUD ROTARY DRILLING (MONITORING WELLS)				
2a	Mud Tub Setup/Breakdown	each	3	
2b	Mud Rotary Drilling: 8-inch borehole, 0-500' bgs *(to include thinning mud)*	foot	1,500	
2c	Bulk Transport: Cuttings and Drilling Mud *(to include shoveling cuttings to roll-off container, pumping off liquid fraction in roll-off container, and transport of liquid fraction to water tank located at project support area)*	hour	30	
2d	Drum Transport/Staging *(to include filling/securing drums with plastic/PPE, transport to project support area, and staging on pallets with rings facing outward)*	drum	30	
3. OUTER SCREEN/CASING ASSEMBLY INSTALLATION AND DEVELOPMENT (MONITORING WELLS)				
3a	Outer Screen: Stainless Steel Type 304, Schedule 10 *(10-slot, wire-wound, flush threaded, 5-foot sections; to*	foot	150	
3b	Outer Casing: Stainless Steel Type 304, Schedule 10 *(to include associated annular materials)*	foot	1,350	
3c	Flush Mount Completion *(to include 10-inch flush-mount manhole protective casing, concrete pad, well cap, keyed-alike lock, etc)*	each	3	
3d	Outer Screen Interval Development *(to include setup/breakdown of development equipment and pumping time; does not include non-pumping time. assume 6 hours/interval)*	hour	180	
3e	Bulk Transport: Development Water *(to include transport from well location to water tank located at project support area)*	hour	60	

4. WESTBAY MULTI-PORT MONITORING WELL INSTALLATION				
4a	Westbay MP38 Multi-port Monitoring Well Installation *(to include assembly and installation of multi-port well under Westbay direction)*	day	6	
4b	Westbay MP38 Multi-port Monitoring Well Equipment and Supplies *(wells to 500' bgs, 10 ports each; to include all equipment/supplies/Westbay instruction to install and test each well)*	each	3	
5. GEOTECHNICAL INVESTIGATION				
5a	Conduct Recharge Basin Percolation Tests *(to include backhoe rental and all supplies/ equipment; assume 5 hours/test)*	each	4	
5b	3.25" ID HSA Drilling: Recharge Basin and Treatment Facility Geotechnical Borings *(borings to 35' bgs; to include shoveling cuttings to drums)*	foot	210	
5c	2" Split Spoon Sampling: Recharge Basin and Treatment Facility Geotechnical Borings	each	48	
5d	Drum Transport/Staging *(to include transport to project support area, and staging on pallets with rings facing outward)*	each	5	
5e	Geotechnical Soil Sample/Analysis: Particle Size ASTM D421/D422 *(to include pre-cleaned sample jars, collecting/shipping sample, and analysis)*	each	48	
5f	Geotechnical Soil Sample/Analysis: Moisture Content ASTM D2216 *(to include pre-cleaned sample jars, collecting/shipping sample, and analysis)*	each	20	
5g	Borehole Abandonment	foot	210	
5h	Geotechnical Report	lump sum	1	
6. OPTIONAL ITEMS				
6a	Night/Weekend Rate Differential	hour	20	
6b	Night/Weekend Security Guard	day	60	
6c	Level C Surcharge	hour	16	
6d	Geotechnical Soil Sample/Analysis: Atterberg Limits ASTM D4318 *(to include pre-cleaned sample jars, collecting/shipping sample, and analysis)*	each	100	
6e	Geotechnical Soil Sample/Analysis: UU Triaxial Test *(to include pre-cleaned sample jars, collecting/shipping sample, and analysis)*	each	100	

NOTES:

CDM Representative Signature:

Drilling Representative Signature:

DRUM TRACKING LOG

SITE NAME: OLD ROOSEVELT FIELD CONTAMIANTED GROUNDWATER AREA SITE

Drum #	Boring/MW#	Date Drilled/ Sampled	Related Sample #	Description of Drum Contents	Signature

OLD ROOSEVELT FIELD CONTAMINATED GROUNDWATER AREA SITE
FIELD CHANGE REQUEST (FCR) FORM

REQUEST NO: ______________________ DATE: __________________

FCR TITLE: ____

DESCRIPTION: ____

____

____

REASON FOR DEVIATION: (Include impact on project objectives)

____

____

____

RECOMMENDED/MODIFICATION: ____

____

____

IMPACT ON PROJECT OBJECTIVES: ____

____

____

____

Signatures: ________________________________ ____________________
Field Team Leader (FTL) Date

________________________________ ____________________
CDM Project Manager (PM) Date

Distribution: EPA Remedial Project Manager
CDM PM
CDM Quality Assurance Coordinator
Field Team
Project File

OLD ROOSEVELT FIELD CONTAMINATED GROUNDWATER AREA SITE
LOW FLOW GROUNDWATER SAMPLING PURGE RECORD

DATE:	**WELL #:**
SAMPLERS:	**DEPTH OF PUMP INTAKE:** ft TIC or ft BGS (circle one)
WEATHER CONDITIONS:	**SCREENED/OPEN BOREHOLE INTERVAL:** ft TIC or ft BGS (circle one)
SAMPLE ID: **CLP ID:** **SAMPLE TIME:**	**SAMPLE FLOW RATE:** ml/minute

		Instrument Type/Model: Complete and/or Circle at right			YSI Model #______________/ Horiba U-22 (circle one) Other (specify)____________________					Instrument:
CURRENT TIME	**VOLUME PURGED**	**DEPTH TO WATER**	**FLOW RATE**	**DRAWDOWN (± 0.3 FT)**	**pH (± 0.1 SU)**	**SPECIFIC CONDUCTIVITY (± 3%)**	**DISSOLVED OXYGEN (± 10%)**	**TEMP. (± 10%)**	**REDOX POTENTIAL (± 10 mV)**	**TURBIDITY (± 10%)**
24-Hour	gallons / liters (circle one)	ft TIC / ft BGS (circle one)	Units:	ft TIC / ft BGS (circle one)	SU	S/cm, mS/cm^c/ or µS/cm (circle one)	mg/L <u>(not %)</u>	Units: °C	mV	NTUs

Drawdown is not to exceed 0.3 feet. Flow rate should not exceed 500 ml/min during purging or 250 ml/min during sampling. Readings should be taken every three to five minutes. The well is considered stabilized and ready for sampling when the indicator parameters have stabilized for three consecutive readings by the measurements indicated in parenthesis.

Typical values: DO = 0.3 - 10 mg/L Redox Potential = -100 - +600 mV Turbidity = 0 - >500 NTUs
Spec. Conductivity (µS/cm) = 0.01 - 5,000; up to 10,000 in industrial, ~55,000 in high salt content water. Note: 1,000 µS/cm = 1 mS/cm

TIC = Top of Inner Casing BGS = Below Ground Surface

Groundwater Sampling Field Data Sheet

Project: ______________________
Monitoring Well No: ______________________
Sampling Zone No(s): ______________________
Sample Probe No: ______________________

Date: ______________________
Start Time: ______________________
Technicians: ______________________

Zone No. (a)	Run No. (b)	Surf. Press. (c)	Surface Function Tests						Position Sampler	Sample Collection checks (Probe located at sampling zone in MP casing.)								Comments (volume retrieved) (s)
			Shoe Out (d)	Close Valve (e)	Check Vacuum (f)	Open Valve (g)	Evacuate Container (h)	Close Valve (i)	Locate Port ( ) Arm Out ( ) Land probe ( ) (j)	Pressure in MP ( ) (k)	Shoe Out (l)	Zone Pressure ( ) (m)	Open Valve (n)	Zone Pressure ( ) (o)	Close Valve (p)	Shoe In (q)	Pressure in MP ®	

Additional Comments: (pH, Turbidity, S.C, etc.)

Water Quality Sampling Record for Westbay® Wells

Date ______________________

Project ______________________

Field Team Member Signature ______________________
(Print name and title, then sign)

WATER SAMPLED:

Well Number: ______________________ Sample Type ______________________

Zone Number: ____________

Depth: ____________

Sampling Period: Start ____________ Complete ____________

SAMPLING INFORMATION

Sampler probe ______________________

Filter Size ______________________

Thermometer ID ______________________

EC Meter ID ______________________

pH Meter ID ______________________

ORP Meter ID ______________________

Alkalinity Kit ID ______________________

Turbidity Kit ID ______________________

Dissolved O_2 Meter ID ______________________

____

____

____

Sample Types

F – Field

FD – Filed Duplicate

FTB – Field Trip Blank

EQB – Euipment Blank

PEB – Performance Equipment Blank

FB – Field Blank

Water Quality Sampling Record for Westbay® Wells (Cont.)

Date ______________

Project ______________

Well Number ______________

Zone Number ______________

Depth ______________

Signature ______________
(Print name and title, then sign)

Time	Run No.	Volume retrieved (liters)	Parameter Measurements							Comments
			pH	EC (µS/cm)	Temp (°C)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Pressure of zone (psi)	ORP(mV)	

SUBMITTAL INFORMATION

Sample ID(s):

Date Submitted to SMO

Westbay® Pressure QA/QC Check Record

Check Record for Serial Number ___________
PSI Guage __________
Error Tolerance _________ (psi)

Date	Met Station	Time of Met Station Barometric Reading	Barometric Pressure at Met Station (mb)	Barometric Pressure at Met Station (psi) (1mb = 0.01450 psi)	Add 0.026 (psi) to Met Station value for TA-64 check location	Time of Probe Reading	Probe Barometric Reading (psia)	Acceptable Range (psi)	Passed?

EQUIPMENT CALIBRATION LOG

Instrument (Name/Model No./Serial No.):
Manufacturer:

Calibration Date	Initial Setting				Lot Control No. Expiration Date	Adj. Made (Y/N)	Final Reading				Comments Pass/Fail	Signature
	Cond.	pH(1)	pH(2)	ORP			Cond.	pH (1)	pH (2)	ORP		

Instrument Calibration Log
RAE Systems
MultiRAE + (4 gas + PID)

Calibration Completed By	Date	Rental Company	Rental Company Number	Instrument Serial Number	Time Instrument On[1]	Warm Up 5 to 10 Minutes[2]

Calibration Gas	Manufacturer	Lot No./Expiration Date	Concentration(s)
			CO: H_2S: LEL: O_2:
			Isobutylene:

Fresh Air Calibration	Carbon Monoxide (CO) Reading	VOC[3] Reading (zero)	H_2S Reading (zero)	LEL Reading (zero)	Oxygen (O_2)
Expected Reading[4]	Zero	Zero	Zero	Zero	20.9%
Actual Reading					

Multiple Sensor Calibration	CO Reading	H_2S Reading	LEL Reading	O_2 Reading	VOC Sensor Calibration	VOC Reading
Expected Reading[5]					Expected Reading	
Actual Reading					Actual Reading	

Instrument OK? YES (Calibration Completed) NO (Problem with instrument, detail in comments)

Calibration Check[6]	Completed (Circle one): YES NO		
Time:	Date:	Calibration Completed By:	
Calibration Gas	Same as Above (Circle one)? YES NO (IF NO COMPLETE INFORMATION BELOW)		
	Manufacturer	Lot No./Expiration Date	Concentration(s)
			CO: H_2S: LEL: O_2:
			Isobutylene:

[1] Note time instrument is turned on for initial warm up
[2] While instrument is warming up, make sure inlet tubing is connected to a hydrophobic filter and fill one Tedlar bag with isobutylene and one with four gas mix
[3] VOC – volatile organic compounds, H_2S – hydrogen sulfide, LEL – lower explosive limit
[4] Instruments should read zero after fresh air calibration is complete, write down actual readings below headings
[5] Write concentration from calibration gas on this line
[6] Complete at the end of the day

Instrument Calibration Log
RAE Systems
MultiRAE + (4 gas + PID)

Calibration Check Readings:				
CO:	H_2S:	LEL:	O_2:	VOC:

Comments/Corrective Action: ____________________

OLD ROOSEVELT FIELD CONTAMINATED GROUNDWATER AREA SITE
SAMPLE TRACKING LOG

LDL VOC LAB: ____________________ INORGANIC CLP LAB: ____________________

CLP CASE NO: ____________________ ORGANIC CLP LAB: ____________________ SUBCONTRACT LAB: ____________________

SAMPLE ID	SAMPLE DATE	SAMPLE TIME	MATRIX	DEPTH (feet)	LDL VOC CLP NO.	ORGANIC CLP NO.	INORGANIC CLP NO.	SUBCONTRACT ANALYSIS	QA/QC

ANALYSIS SUMMARY: ____

____

REV 5/01

SUBCONTRACTOR LABORATORY SAMPLE TRACKING LOG

SITE NAME: OLD ROOSEVELT FIELD CONTAMINATED GROUNDWATER AREA SITE

DATE SHIPPED OR RECEIVED	NUMBER OF SAMPLES SHIPPED (OR SUPPLIES RECEIVED)	ANALYTICAL PARAMETERS REQUIRED	NUMBER OF COOLERS SHIPPED

Appendix D

APPENDIX D

DATA MANAGEMENT

Appendix D
Data Management

The CDM Analytical Services Coordinator (ASC) is responsible for tracking samples from the point of field collection to submittal for laboratory analysis and the subsequent data validation and data management efforts. The sample handling and custody requirements, including field logbook (TSOP 4-1) and generation of sample paperwork, sample labels and custody seals (TSOP 1-2) discussed in Worksheets #26 and #27, will be followed. The laboratory QA requirements including laboratory audits and contract compliance screening will be followed according to procedures described below and in Worksheet#23. The ASC will receive non-RAS data from the laboratory and track it through the data validation process. For non-RAS data, the ASC will submit the electronic "ANSETS Data Requirement" form (Appendix F) to the RSCC by the first day of each month for the previous month's sampling. RAS data will be validated by EPA with contractor support; EPA will be responsible for tracking and maintaining custody of the laboratory data packages through the data validation process. When non-RAS data packages are received from the laboratory, the ASC will initiate a non-RAS Data Package Chain-of-Custody Form. All transfers of the data package from one individual to the next must be recorded on the custody record. The data package itself must remain under lock and key when not undergoing processing. Data validation performed by CDM will be in accordance with the procedures described in Worksheets #35 and #36 of this QAPP. Once the data is validated, it will be input into CDM's database.

A project-specific electronic spreadsheet will be developed for sample tracking purposes prior to field activities. The tracking system will be initiated in the field during sample collection and will be updated during the sample analysis and data validation phases. The data will be entered by project staff and then checked by the ASC for accuracy. This tracking system will ensure that no data is lost during the data management process.

The following information is recorded in the tracking system:

Sample Number

I.	Area of Concern
II.	Sample Matrix
III.	SDG Number
IV.	CLP Case No.
V.	CLP No.
VI.	Analytical Parameter
VII.	Collection Date
VIII.	Shipment Date
IX.	Date Received from Lab
X.	Date Submitted for Data Validation
XI.	Name of Data Validator
XII.	Date of Data Validation Completion
XIII.	Database Entry Date
XIV.	Database QC Date
XV.	Comments (i.e., MS/MSD designation, duplicate samples).

Analytical data collected during the field effort will be entered into an appropriate relational database management system and standard commercial software packages. This management system will include both location and environmental data. Historical data and potentially responsible party data can also be entered. The database management system will provide data storage, retrieval, and analytical capabilities. The system will be able to meet a full range of site and media sampling requirements since it will be able to interface with a variety of spreadsheet, word processing, statistical, and graphics software packages.

To facilitate the use of the database, CDM will provide the laboratories with a detailed format specification for the delivery of analytical data in an electronic diskette deliverable (EDD). Once it is uploaded into the database, validated analytical data will be organized, formatted, and input into the database for use in the data evaluation phase. A 100 percent quality control check will be performed to ensure accuracy on all hand-entered data (i.e., data qualifiers added by CDM validators on subcontract laboratory data, sample field notations).

Data tables that compare the results of the various phases of sampling efforts will be prepared and evaluated. In addition, data tables that compare analytical results with both state and federal ARARs will be prepared. Analytical data results will interface with graphics packages to illustrate contaminants detected. As a quality control check, reports, tables, and graphical figures will be compared to the sample tracking system for errors and omissions. CDM will provide EPA with final analytical data on electronic media.

Data management will utilize personal computers (PC), local area networks (LAN), and electronic communications (ex: the World Wide Web) to support the database management system software. CDM will set up PC stations on which the database management system and commercial software will run in compliance with those software licensing requirements. CDM will take reasonable care to protect the data and will perform periodic backups to prevent wholesale loss of project data. Control of the computer hardware and software will be as per CDM QP 4.1.

After the CLP data has been validated, the package is returned to the EPA RPM. CLP data packages forwarded to CDM ACS will then have copies made of the Region 2 chain-of-custody/data transfer log, validated Form Is, data validation assessment and data validation checklist for distribution to the site manager and RAC II document control files. The original CLP data package with all associated forms is retained by EPA for archival. Non-CLP data packages received from the RAC II BOA laboratory subcontractor are sent for data validation, then returned to the ASC. These packages are copied and distributed to the site manager and RAC II document control files. Copies of the non-CLP data packages will be submitted to EPA during project close-out.

Appendix E

APPENDIX E

MOSDAX SAMPLER PROBE OPERATIONS MANUAL

APPENDIX A

WESTBAY SAMPLING PROTOCOL (Reprinted with Permission)

PASSIVE DIFFUSION BAG SAMPLING PROTOCOL

WELL DEVELOPMENT AND NON-VOLATILE SAMPLING PROTOCOL

APPENDIX A
CONTENTS

A1.0 WESTBAY SAMPLING PROTOCOL (REPRINTED WITH PERMISSION)

NOTICE

Operation of the MP System equipment should only be undertaken by qualified instrument technicians who have been trained by Westbay authorized personnel.

DO NOT OPEN THE SAMPLER

All warranties expressed or implied will be void if, after examination by Westbay Instruments Inc. personnel, it is established that any of the instrument housings have been opened without prior authorization from Westbay Instruments Inc.

DO NOT LET THE SAMPLER FREEZE

Extreme care should be taken to avoid freezing the MOSDAX Sampler probe. Permanent transducer damage may result from freezing.

Manual Revision: 1.1

Issued for Serial No.: ____________

Date: ____________

Signature: ____________

Contents

1. DESCRIPTION

1.1 MOSDAX Sampler Probe, Model 2531

The MOSDAX Sampler is a downhole probe designed to collect fluid pressure information and fluid samples from MP System monitoring wells. Each MOSDAX pressure sensor is calibrated over its full pressure range for nonlinearity and temperature variation. MOSDAX Sampler probes are available in a variety of pressure ranges to permit operation to various depths. The shoe and valve motors can be operated from the surface. The power for the shoe and valve motors is supplied from the surface.

1.2 MOSDAX Personal Computer Interface (MPCI), Model 2522

The MOSDAX Sampler can be operated with an IBM compatible computer or MOSDAX Handheld Controller (HHC). The MPCI translates the signals between the computer or HHC and the MOSDAX Sampler. The MPCI requires 12 volt DC power to operate. An optional barometric transducer module is available for the MPCI which allows barometric pressures to be monitored while the probe is being operated.

1.3 Cable Reels

The manual cable reel can operate all of Westbay's probes and tools to a depth of 300m (1,000 ft) on a single-conductor cable. The manual reel is hand operated with an internal brake to control the speed of descent of the probe in the well. The two-pin cable connects the MPCI to the reel and the signals pass through a slipring located in the hub of the reel into the control cable. For maintenance information, see the appropriate cable reel manual.

Motorized cable reels are available for deeper applications.

1.4 Sample Containers

Sample containers can be used with the MOSDAX Sampler. The nonvented stainless steel sample bottles maintain samples under formation pressure while the sampler and bottle are brought to the surface.

2. PRESSURE PROFILING

2.1 Items Required

- MOSDAX Sampler Probe, Model 2531
- MOSDAX Personal Computer Interface (MPCI), Model 2522 with:
  - one two-pin data cable
  - one three-pin power cable
  - one nine-pin computer cable
- IBM compatible computer with MProfile software or a Handheld Controller.
- MOSDAX series cable reel.
- Sheave with counter and tripod.
- 12 VDC, 2 Amp power source (Battery pack, car/truck battery, or transformer).
- Water level measuring tape.
- MProfile User's Guide for computer or the Handheld Controller Operations Manual
- MP Casing Log showing depths to ports and couplings in hole to be tested.

2.2 Surface Checks

1. Remove the MOSDAX Sampler from its storage case. Inspect the probe housing and body for any damage. Please contact Westbay for advice on any cover tube damage.
2. Assemble the tripod and counter over the well. Run the cable over the counter.
3. Connect the probe to the cable. Before attaching, inspect the O-ring at the top of the probe and lubricate with silicon. The O-ring should be clean and intact. Tighten the nut hand tight only.
4. Connect the two-pin cable from the MPCI to the cable reel. With the MPCI OFF connect the three-pin cable from the MPCI to the 12 v power supply.
5. Connect the 9 pin cable from computer or HHC to the MPCI and turn the MPCI ON.
6. Perform the following surface checks to ensure that the location arm and the shoe mechanisms are operating normally: Release the location arm. The location arm should extend smoothly. The number of revolutions used to release the location arm is displayed and should be 15 to 16 revolutions. If a smaller number of revolutions is reported, retract the arm and repeat. Place the probe in a piece of MP casing or coupling. Activate the shoe. The shoe should extend and hold the probe firmly in the coupling or casing. The display should indicate 16 to 19 revolutions. A reading of 23 revolutions indicates the probe is activated in open air. Retract the backing shoe.

7. Check that the face plate for sampling and the plastic plunger are installed on the sampler.
8. The probe is now ready to be lowered down the well.

2.3 Pressure Measurement Procedures

1. Obtain the completed MP Casing Log.
2. With the location arm retracted, lower the probe into the MP casing to immediately below the lowest measurement port coupling to be monitored. If magnetic collars have been installed on the well, the Collar Detect Command can be used to detect the collars. The Collar Detect Command is cancelled by pressing any key.
3. Release the location arm. The display should update and beep after the arm is released.
4. Raise the probe about 0.5 m (1.5 ft) above this measurement port. If the probe is accidentally lifted above the next higher coupling, it will be necessary to retract the location arm and lower the probe to below the measurement port and release the arm.
5. Lower the probe gently until the location arm rests in the measurement port.
6. Record the pressure and temperature inside the MP casing.
7. Optional: If a water level tape is available, measure and record the depth to water in the MP casing.
8. Activate the shoe. The pressure on the display should change to the formation pressure.
9. When the reading has stabilized, record the formation pressure.
10. Once the pressure has been recorded, retract the shoe.
11. Record the pressure of the fluid in the MP casing. This reading should be similar to that recorded in Step 6. If a large difference is noted between the readings, record the water level inside the MP casing again using the water level tape.
12. The three pressure readings plus the time and water level constitute a complete set of readings at a measurement port coupling.
13. Continue up the MP casing to obtain the pressure data from other measurement ports.
14. Take one last set of pressure and temperature readings at the surface. These readings should be similar to those recorded in Step 2.

CAUTION: **If a water level tape was used, remove the water level tape from the MP casing before removing the sampler probe from the well to prevent them from becoming jammed.**

3. FLUID SAMPLING

3.1 Items Required

- MOSDAX Sampler, Model 2531
- MPCI (Model 2522), with cables as described in Section 2.1
- IBM compatible computer with MProfile software or a Handheld Controller
- MProfile Users' Guide for the computer or the Handheld Controller Operations Manual
- MOSDAX series cable reel.
- Sample containers and connecting tubes
- MP Casing Log
- Groundwater Sampling Field Data Sheet
- 12 VDC, 2 amp power source (battery pack, car/truck, or transformer)
- Counter and tripod
- Westbay Sampling Kit including vacuum hand pump

3.2 Surface Checks and Preparation

1. Set up the MOSDAX Sampler probe following Steps 1 through 8 of Section 2.2.
2. Attach the sample containers.
3. Release the location arm. Locate the probe in the vacuum coupling.
4. Activate the shoe in the vacuum coupling.
5. Close the sampler valve. The motor should run about 5 seconds. The display should indicate one revolution.
6. Use the vacuum pump to apply a vacuum through the vacuum coupling. The vacuum should remain constant. If the vacuum is not maintained, inspect for leaks at the face seal of the probe, the connection to the pump and at the probe sampling valve.
7. Once a vacuum has been maintained, open the sampler valve. Apply a vacuum again to check that all connections are sealed.
8. Close the sampler valve. A vacuum has now been applied to the sample bottles.
9. Retract the shoe.

3.3 Drillhole Sampling

1. Check recent pressure logs of the hole and ensure that the head inside the MP casing is lower than the head outside the measurement port to be sampled.
2. After completing the surface checks, follow Steps 1 to 5 of Section 2.3 to locate the sampler at the measurement port in the monitoring zone to be sampled.
3. Record the pressure reading.
4. Activate the probe and record the formation pressure.
5. Open the sampler valve. The pressure should drop and then slowly increase as the bottles fill. When the pressure in the bottle equals the zone pressure from Step 4, the bottle is full. Wait a maximum of two minutes per sample bottle even if the pressures are not equal.
6. Close the sampler valve and retract the shoe.
7. Record the pressure reading. A reading the same as in Step 3 indicates that the sample is OK.
8. Reel the sampler to the surface and remove it from the MP casing.
9. **Do not open the sampler valve as damage to the probe or injury to the operator could occur.**
10. Remove the cap from the bottom sample bottle and open the valve on the bottle to release the pressure and to transfer the sample.
11. Open the sampler valve to allow the sample to flow from the bottles. Once the pressure in the sampler and bottles has decreased to atmospheric, the bottles may be disconnected to speed the process.
12. Take particular care in handling pressurized samples.

3.4 Rinsing Instructions

Rinse the sampler around the face seal and the bottom connector. With the sampler valve open, flush the interior of the sampler from the bottom connector. Rinse the sample bottles and connectors.

Note: Project specific procedures for decontaminating the sampler and sample bottles are the responsibility of the project manager and are not covered in this manual.

4. Care and Maintenance

The MOSDAX Sampler System must be routinely maintained for optimum performance. The procedures outlined here are required to keep the instrument operating properly. For any additional information or advice, please contact Westbay Instruments Inc.

4.1 MPCI

The MPCI should be cleaned to remove dirt and dust and inspected for damage or wear. If any part requires replacement, contact Westbay for information.

4.2 Cable Reels and Control Cable

The cable reels should be kept clean and protected from damage. The cable and cable head should be inspected for kinks and corrosion. Rehead the cable if necessary. For more information concerning cable reels and the control cable, refer to the appropriate reel manual.

4.3 MOSDAX Sampler Probe

1. Never allow the probe to freeze or the pressure transducer may be damaged.
2. Clean and inspect the probe for dents and scratches on the cover tube. Clean the threads with a nylon brush, such as a toothbrush. DO NOT use a wire brush. Protect the O-rings from damage and dirt.

4.3.1 Face Seal

Inspect the face seal and replace if damaged or worn.

1. Remove the two screws holding the face plate to the probe body and lift the face plate off.
2. Remove the face seal and plunger. Set the location arm assembly aside. Clean the plunger and probe body.
3. When reinstalling the face plate hold the face seal, plunger and location arm assembly in place. Replace the two screws the hold the face plate on the probe.

4.3.2 Location Arm

Release the location arm. Check that the arm moves smoothly and freely and check for damage and sharp edges due to wear. Replace the location arm if necessary.

1. Release the location arm. Remove the two screws and face plate (Section 4.3.1).
2. Remove the location arm with its spring and pivot pin. Clean and inspect all parts and replace if needed.
3. Insert the spring and pivot in the location arm and place the assembly in the probe body. Place the face plate over the face seal and location arm and tighten the two

screws. Check that the arm is moving freely and the face seal insert and plunger are held securely in place.

4.3.3 Button Shoe Replacement

Activate the shoe and inspect for damage or wear. The shoe should rotate freely about the pivot pin. When the shoe is retracted it should retract quickly and smoothly back into the probe. The shoe may be replaced in the following manner:

1. Release the location arm and extend the shoe to expose the pivot pin.
2. Unscrew the shoe pivot pin from the lever arm and remove the shoe.
3. Place a new shoe in the lever arm and install the shoe pivot pin.

4.3.4 Actuator Nut

The actuator nut needs to be routinely cleaned to remove particles of grit which can interfere with its movement. Remove the actuator nut in the following manner:

1. Remove the two set screws that hold in the lever arm pivot pin. Using the Allen key, push the lever pivot pin out of the probe body.
2. Remove the set screws on the side of the probe body that holds the plastic support block.
3. Remove the screw closest to the top of the probe.
4. Lift out the lever arm, guide plate, shoe, spring and plastic support block as one unit.
5. Use the Clean Nut Command to remove the actuator nut from the actuator screw. Turn off the MPCI and remove the nut from the probe.
6. Clean the actuator nut with the cleaning tap. Use the Clean Nut Command and clean the actuator screw with a nylon brush. DO NOT use a wire brush.
7. Apply a thin coating of silicone lubricant to the actuator screw. Place the actuator nut in the probe body against the actuator screw and retract the arm to thread the nut onto the actuator screw. Allow the nut to travel along the full length of the screw. YOU MAY HAVE TO REPEAT THIS OPERATION.
8. Install the single unit from Step 4 in the probe body. Install the lever arm pin through the probe body, lever arm, and spring. Lock the pin in position with two set screws.
9. Install the top screw into the guide plate and install the set screws to secure the support block.

5. CALIBRATION

The MP System permits frequent or periodic calibration of the transducers used for pressure measurement. Contact Westbay for details.

6. SPARE PARTS LIST

Item	Part No. or Size	Qty
Face Seal Insert	200302	2
Plunger	200303	1
Shoe Button	252313	5
Shoe Spring	252318	2
Location Arm	252112	5
Location Arm Pivot	252316	2
Location Arm Spring	252319	2
Termination Sleeve	251805	1
Termination Insert	251806	1
Bulkhead Connector	PF0601JF	1
Boot	JF0602CF	1
Contact	JF0603CF	1
Fuse, 1.5 GMA	FH0150AE	2
O-ring	# 110 B	2
O-ring	# 111 B	2
O-ring	# 005 B	10
O-ring	# 006 B	10
Support Insert	253120	2
Manifold	253111	1
Bushing 4	253110	1
Pan Head Screw	# 4-40 x 1/4 - inch	2
Pan Head Screw	# 6-32 x 3/16 - inch	2
Pan Head Screw	# 6-32 x 1/2 - inch	2
Hex Socket Head Screw	# 8-32 x 1/8 - inch	4
Hex Socket Head Screw	# 10-32 x 3/16 - inch	4
Hex Socket Set Screw	# 8-32 x 5/16 - inch	2
Allen Key	5/64 - inch	1
Allen Key	3/32 - inch	1
Actuator Nut Tap	208001	1
Cable Heading Tool	208100	1

A2.0 PASSIVE DIFFUSION BAG SAMPLING PROTOCOL

A2.1 Obtain PDB Sampler Hardware

- The hardware for each well in the sampling program will be custom-made prior to the initiation of the field program
- Each hardware kit is labeled for each well, and should closely match the dimensions submitted to the kit manufacturer
- Open the hardware kit bag and carefully unwind the first few feet of cable to expose the first set of plastic disks that the PDB samplers will hang from

A2.2 Install PDB Sampler Hardware

- Unseal the appropriate PDB sampler hardware kit (match label to well name) and carefully retrieve hardware
- Clip the first (bottom) PDB sampler onto the top and bottom plastic disks using the available zip-ties
- Record time and bag position in the well
- If this well is to be profiled, continue attaching PDB samplers to remaining disks for this monitoring well
- Otherwise, if this well is not scheduled to be profiled and has not yet been profiled, continue unwinding the hardware kit until the uppermost set of plastic disks is exposed and then attach the second PDB sampler
- Once a well has been profiled and a specific depth has been selected from which to monitor groundwater quality, only one PDB sampler will be installed on the hardware kit – the depth interval will be noted on the field instruction form

- QC bags (duplicate samples) should be paired with field sample bags (share loops)

- Once the necessary PDB samplers have been installed, carefully lower the hardware kit until the stainless steel weight touches the well bottom

- Confirm that the top clip roughly equals the top of casing and adjust as necessary to ensure a snug fit (slightly taught line) when the well cap is closed

- Attach the end of the hardware line to the well head hanging device – make sure that the PDB sampler kit does not sag when well cap is closed

- Secure the well

A2.3 Sample Naming/Recording

- Sample numbers will be generated as specified in the CDQMP and SAP (normal)

- Field personnel must include a depth for each sampler on the chain-of-custody

- Record the relative position of each bag – they will be numbered in the order they will be **retrieved** (i.e., top → #1.... #2.... #n.... → bottom) – in other words, the first PDB sampler to be installed will have the highest number and the last PDB sampler will have the lowest number

A2.4 PDB Sampler Retrieval

- Collect the appropriate number of VOA vials for the required number of VOC samples

- Note the time and begin reeling the PDB sampler hardware line

- Important - the contents of each bag must be transferred to the VOA vials within 15 minutes to avoid losing volatile compounds to atmosphere. Once the first bag leaves the water, the time limit starts at the same time for all exposed bags.

- Remove the first PDB sampler and use the provided hole punch or 'juice straw' to puncture the bag
- Carefully empty contents into VOA vials (preferably set up in a bottle holder)
- Apply completed label to each VOA vial to ensure that they are not confused later
- Repeat until all PDB samplers have been removed and contents transferred
- Store all filled VOA vials in properly cooled container with packing
- Follow above guidelines to re-install new PDB samplers as scheduled (profile or two-bag scenario)
- Dispose of all used PDS bags and components appropriately as either IDW or recyclable material
- Decontaminate all reusable equipment with clean water and ALCONOX.

A3.0 WELL DEVELOPMENT AND NON-VOLATILE SAMPLING PROTOCOL

A3.1 Groundwater Sampling For Non-Volatile Compounds

This section presents the procedures to be followed before, during, and after sampling groundwater from wells where samples other than VOCs will be collected. Before placing any groundwater sampling equipment in a well, decontamination of the equipment must be performed.

Prior to sampling, the wellhead will be examined for signs of tampering or deterioration and observations noted. Results will be recorded in the field notebook. Sampling for non-volatile compounds will use one of the following methods.

Bailers

Bailers may be dedicated to a single well, decontaminated and used for multiple-well purging, or disposable single-use type.

Suction-Life Pumps

The common types are centrifugal, peristaltic, and hand-operated diaphragm p[umps. The pumps can be used for both well purging and sampling (inorganic analysis samples) or well purging alone. For purging, these pumps should be equipped with foot-valves to prevent purge water from flowing back down the well and potentially volatilizing VOCs.

Submersible Pumps

If purging is accomplished using a submersible pump, the pump will be set just below the water level so that all standing water is removed form the well. Placement of the pump for purging should take into consideration the anticipated depth to which water will be drawn down during pumping. The volume of water purged and the extraction rates will be recorded. Purge rates will be sustainable and executed at a rate that minimizes drawdown to prevent water from cascading into the well.

Bladder Pumps

The pumps generally consist of an internal collapsible membrane that is filled and evacuated by means of compressed air or inert gas, forcing the water through check valves to the surface via discharge lines.

In-Situ Sampling

Non-volatile compounds can be sampled directly from the screen interval by use of either a bomb sampler or a discrete sampler. The sample chamber is lowered into the well to be sampled on the cable. When the chamber reaches the desired depth of sampling it is opened by a second cable and allowed to fill. The bomb is then retrieved and samples are transferred to containers to be analyzed in a laboratory.

Well Purging

For non-passive well sampling methods, wells will be purged before sampling to provide water that is representative of the aquifer conditions.

As a minimum, three well volumes will be purged from all wells unless the well pumps dry or unless well-specific conditions indicate different purging requirements. Purging should continue until field parameters have stabilized, not when a particular number of well volumes have been removed. Well indicator parameters (temperature, electrical conductivity, and pH) will be monitored during purging to verify complete purging of standing water in the well casing. Stabilization of thee parameters will consist of three consecutive measurements of pH within ±0.1 unit, temperature within ±0.1 degree, and conductivity within 10 percent. At least six measurements will be obtained (1 measurement per ½ well volume) to document purging parameters. If the well does not stabilize after purging a minimum of five well volumes, sampling will commence.

If the well pumps "dry" during purging before three (or the required number) of purge volumes are removed, several options are available.

1. If the water level recovers within 0.5 to 1 hour, the purge can be repeated until three well volumes are removed.

2. If the water level recovers within 8 hours, purging can be performed once early in the day and sampling can be performed after the water level has recovered to within 80 percent of the static water level.

3. If the water level does not recover after 24 hours, purging can be performed once on one day and the samples can be collected the next day.

A3.2 Monitoring Well Development

After the grout has set for at lest 24 hours, each new well will be developed by swabbing, surging, bailing, pumping, or air lifting. A well development rig will be used if conditions warrant. Any equipment used for well development will be thoroughly cleaned before use to prevent possible well contamination. Depending on the depth of the well, one or more of the methods described below will be used. During development, indicator parameters (temperature, electrical conductivity, turbidity, and pH) will be monitored and recorded on well development forms and documented in the field logbook. Each well will be developed with the goal of obtaining a 5 nephelometric turbidity unit (NTU) standard as measured in the field with a turbidity meter. If the 5 NTU well development goal cannot be achieved with reasonable effort, wells will be considered developed when the indicator parameters listed above have stabilized, and/or up to 15 well volumes have been removed. If the 5 NTU goal has not been achieved prior to the removal of 15 well volumes, the final NTU value will be documented in the field logbook and on the well sampling form. In addition, field notes, observations, and descriptions of methods and procedures used in well development will be submitted to the USACE as part of the quality control summary report. All well development water will be contained and subsequently disposed in accordance with federal, state, and local regulations.

Bailing: Bailing will generally not be sufficient by itself to fully develop a well and will generally be used in conjunction with pumping and/or surging. Care must be taken while bailing to prevent dropping the bailer onto the bottom cap of the well and to not bail too fast so as to avoid causing the well joints to part.

Swabbing: This technique is used to surge water back and forth through the well screen to facilitate sediment removal. Since it generally does not entail removal of any water from the well, this technique will be typically followed by bailing to remove the sediment from the well. Care must be taken to not move the surge block too fast to prevent the casing joints from parting or damage to the screen.

Pumping: If pumping is the only development technique used, the pump will not be equipped with a check valve. The pump will be turned alternately on and off to allow water in the riser pipe to flow back into the well, and will be pumped at a discharge rate greater than what is anticipated for long-term groundwater production (over pumping).

Air Lifting: The air lift method involves pumping compressed air down a pipe placed inside the well casing or a separate eductor pipe. Pressure applied intermittently and for short periods causes the water to surge up and down inside the casing. Once the desired purging is accomplished, continuously applied air pressure will be used to eject water and suspended sediments from the well.